EARL OF MONTAGUE, 25,009, A. J. C. C.

Sire, Young Pedro, 9,033. ***Dropped October 21, 1889.*** ***Dam, Sultane Pogis, 42,157.***

Property of Vermont Agricultural Experiment Station.

Half-Brother of Eurotisama (945 lbs. 1 oz. butter in one year.) Great Grandson of Eurotas, (778 lbs. 1 oz. butter in one year.) His Great Grandmother, was Full Sister of Mary Anne of St. Lambert, (867 lbs. $14\frac{3}{4}$ oz. butter in one year.)

STATE OF VERMONT.

EIGHTH

ANNUAL REPORT

OF THE

VERMONT AGRICULTURAL

EXPERIMENT STATION.

1894.

MONTPELIER:
The Watchman Publishing Co.,
1895.

THE VERMONT

Agricultural Experiment Station,

BURLINGTON, VT.

BOARD OF CONTROL:

PRES. M. H. BUCKHAM, *ex-officio*, Burlington.
HON. E. J. ORMSBEE, Brandon.
HON. CROSBY MILLER, Pomfret.
HON. CASSIUS PECK, Brookfield.
HON. G. S. FASSETT, Enosburgh.

OFFICERS OF THE STATION.

J. L. HILLS.......... Director and Chemist
G. H. PERKINS.......... Entomologist
L. R. JONES.......... Botanist
F. A. RICH.......... Veterinarian
B. O. WHITE.......... Assistant Chemist
*F. A. HOLBROOK.......... Assistant Chemist
D. D. HOWE.......... Farm Superintendent
J. E. FINN.......... Dairyman
MARY A. BENSON.......... Stenographer
E. H. POWELL.......... Treasurer

*Connected with the Fertilizer Control, March 1 to June 1.

ANNOUNCEMENT.

The Vermont State Agricultural Experiment Station was established in accordance with an Act of the General Assembly approved November 24th, 1886, for the purpose of promoting agriculture by scientific investigation and experiment.

The Station was established in connection with the University of Vermont and State Agricultural College, and for the past seven years has received the funds appropriated by Congress under the provisions of the Act commonly known as the "Hatch Act," approved March 2, 1887. The State appropriation expired in 1890.

The Station is prepared to analyze and test fertilizers, cattle foods, seeds, milk and other agricultural materials and products, to identify grasses, weeds and useful or injurious insects, and to give information on various subjects of agricultural science for the use and advantage of the citizens of Vermont.

All chemical analyses, seed investigations, etc., proper to an experiment station, that can be used for the public benefit, will be made without charge. The Station will undertake no work the results of which are not at its disposal to use or publish if deemed advisable for the public good. The results of each analysis or examination will be promptly communicated to the party sending the sample. Those that are of general interest will be published in bulletins, copies of which will be sent to each post-office in the State. The work of the year will be summed up in the annual report of the Station.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Vermont citizen who is concerned in agriculture, whether farmer, manufacturer or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications so far as it lies in its power. All communications relating to agriculture, horticulture, plant or animal diseases, insects, etc., will be fairly considered, and, so far as possible, promptly answered.

The Station offices and laboratories are in the Station building, corner of Main Street and University Place. The Station farm and buildings are on the Williston road, adjoining the University grounds on the east. Electric cars pass within a quarter of a mile of the Station building, at Colchester Avenue and University Place. Both the Station and the farm have telephone connection (Station, "Burlington, 155-4," farm, "Burlington, 155-2") and may be spoken from most telephone offices in the State.

☞Instructions for taking samples of fertilizers, fodders, milk, etc., will be sent on application. Parties desiring to send samples should first write for these directions. Many of the samples received are of little use because they are incorrectly drawn. Parcels by express, to receive attention, should be prepaid.

☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the

AGRICULTURAL EXPERIMENT STATION,

BURLINGTON, VT.

TABLE OF CONTENTS.

FINANCIAL REPORT

For the Fiscal Year Ending June 30th, 1894.

Vermont Agricultural Experiment Station,

In Account with the United States.

Dr.		
To appropriation		$15,000 00
Cr.		
By Salaries	$3,980 33	
" Labor	4,235 80	
" Buildings	708 07	
" Water, gas, fuel and telephone	394 15	
" Library	39 44	
" Apparatus	287 14	
" Chemicals	61 22	
" Horticultural supplies	481 37	
" Vehicles	52 98	
" Tools and farm implements	52 75	
" Stationery, postage and telegrams	90 10	
" Printing	899 27	
" Live stock	700 63	
" Traveling expenses	553 59	
" Freight, cartage and express	103 27	
" Incidentals	261 23	
" Supplies	2,098 66	
		$15,000 00

We, the undersigned, duly appointed auditors for the corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of the University of Vermont and State Agricultural College, for the fiscal year ending June 30, 1894; that we have found the same well kept, and correctly classified as above, and that the receipts for the time named are shown to have been $15,000.00, and the corresponding disbursements $15,000.00 for all of which proper vouchers are on file, and have been by us examined and found correct.

M. H. BUCKHAM,
CASSIUS PECK,
G. S. FASSETT.

Auditing Committee of the Board of Trustees.

I hereby certify that the foregoing statement of account, to which this is attached, is a true statement from the books of account of the institution named.

{ SEAL. }

E. HENRY POWELL,
Treasurer.

We, the undersigned, do hereby certify that the above is the signature of E. Henry Powell, treasurer of the University of Vermont and State Agricultural College, and that the above is the seal of said institution.

G. G. BENEDICT,
Secretary, University of Vermont and State Agricultural College.

JOSEPH L. HILLS,
Director of Experiment Station.

REPORT OF THE DIRECTOR.

The present report covers the work of the Station from January 1 to December 31, 1894, although a considerable part of the feeding tests, which were begun between these dates, was not finished at the close of the year. The financial report covers the year ending June 30, 1894.

PUBLICATIONS.

Four regular bulletins, one special bulletin and the annual report have been issued during the year, aggregating (excluding the special bulletin) two hundred and fifty-three pages of printed matter.

April.	No. 41—Analyses of Commercial Fertilizers, 16 Pages.
July.	No. 42—Bovine Tuberculosis; 54 pages, 4 plates.
October.	Seventh Annual Report; 151 pages.
November.	Special Bulletin; Abstracts of Lectures on Dairying, Vermont Dairy School (extracted from Fourteenth Report, State Board of Agriculture); 87 pages.
November.	Household Pests; 8 pages.
December.	Spraying Orchards and Potato Fields; 24 pages, 7 plates.

The regular bulletins and reports were distributed to our entire mailing list; the special bulletin will be sent on application to those who have not received the Report of the Board of Agriculture. The Report is already out of print, and although two thousand extra copies of Bulletin 42 were printed, the supply is exhausted. It is reprinted entire in this Report.

CHANGES IN STATION STAFF AND EQUIPMENT.

The only change in the working force of the Station during the year was caused by the resignation of Mr. A. G. Gulley, horticulturist, on August 1st. The main addition to the equipment of the Station during 1894, consists of the purchase of an entirely new herd of cows, numbering about forty head, to replace those killed early in the year because of tuberculosis.

The new herd contains high grade Jerseys and a few registered Ayrshires. The former were bought for the Station by Hon. Cassius Peck of the Board of Control, from several herds in Orange County, the latter from the herds of Hon. C. M. Winslow of Brandon and Mr. L. S. Drew of Burlington.

The new herd is now (1895) headed by the famous bull, Earl of Montague, 25,009 A. J. C. C., formerly the head of the herds of Col. R. J. Kimball of Randolph, and the Pratt Institute of Brooklyn, L. I.

WORK OF THE YEAR.

The lines of work during 1894 have been much the same as those pursued in previous years. One notable addition, however, is an investigation

of bovine tuberculosis. Experiments in bee-keeping have also been carried out under the direction of a committee of the Vermont Bee-keepers Association. The results of these as well as of other lines of investigation, are briefly summarized under appropriate headings in the following pages.

BOVINE TUBERCULOSIS.

This subject has been largely discussed in New England and the Middle States within the past two years, (1894-95) largely because of the revelations made by tuberculin used as a diagnostic.

Tuberculin is made from pure cultures (growth separate from all other germs) of the tubercle bacillus, concentrated, sterilized (to kill all germ life) and filtered. It contains the chemical poisons created by the life functions of the germs. Although a failure as a cure for tuberculosis, it has been successfully used to detect its existence in cattle. If a small quantity is injected into a tuberculous animal it will produce a fever, while if the animal is healthy and it is properly used there should be no rise of temperature. An increase of two degrees above normal after injection is ground for suspicion.

A general test of the Station herd was planned late in the fall of 1893, but was not made until New Year's day. It was then found that the herd was badly infected. But two cows were out of condition, yet twenty-four animals reacted at this and subsequent tests. The infected animals were killed, and the post-mortems confirmed the test throughout, while two animals which did not react showed no disease upon slaughter. The distribution of the disease was: Lungs, 90 per cent., udder and its glands, 73 per cent., intestines and mesenteric glands, 50 per cent. Physical examination alone did not detect disease in several cases. Six of the cattle were brought from herds which we now believe were affected with tuberculosis. The disease was located at each end of the barn. The barn was disinfected by burning sulphur and by spraying a dilute solution of corrosive sublimate over the wood work.

Warned by this severe experience the Station officers have exercised all possible care to prevent further disease. All accessions to the herd were tested with tuberculin before admission and have been and are to be re-tested twice a year. The present herd was bought in three lots in April and October, 1894, and January, 1895. The April lot has now been tested thrice, the other two lots, twice. No animal was admitted or will be kept in the herd unless free from tuberculosis. No member of the new herd has as yet been found tuberculous. Its continued good health is reason for congratulation, and is evidence of a negative nature that properly prepared and carefully handled tuberculin cannot cause tuberculosis.

The Station veterinarian has made at the date of writing about 2,400 injections of tuberculin mainly in connection with the work of the Cattle Commission. Of 1,809 Vermont cattle tested, 234 were found to be tuberculous. This number includes four herds which were badly diseased; omitting these four herds the tests include 1,611 Vermont cattle, of which 88 were found to be tuberculous. This ratio should not be thought of necessity to indicate

the percentage of tuberculous cattle in the State, for the injections were usually made in herds where there was reason to suspect the existence of the disease. The attention of those interested is called to the State law on pages 17-18 of this report.

FERTILIZER CONTROL.

The Station made analyses of commercial fertilizers in the spring as usual. Fifty-three brands, or seventeen more than had been analyzed in any previous year, were tested and the results published early in May. A comparison of the average composition of the goods sold in 1893 and 1894 showed the latter to be the poorer, the valuation being $1.62 below that of 1893; in fact the average 1894 goods were of lower grade than any sold since the Station has been in existence. But a third of the brands were up to guarantee, a half were deficient in single ingredients, and a sixth in two ingredients. Five-sixths of the brands, however, gave the commercial equivalent of their guarantees. The percentage of increase of cost over valuation of the average fertilizer was 47 per cent, the highest yet known in this State.

PIG FEEDING.

Experiments in feeding pigs with the by-products of the dairy have been continued as in previous years. A repetition of the test of the preceding year on the effects of relatively watery and concentrated rations was tried as well as a test of the comparative feeding values of skim milk and butter milk. The points brought out in the feeding trials are briefly as follows:

1. The cost of food per pound of increase in live weight, and the profits were slightly in favor of the less watery ration.
2. The shrinkages in dressing were the same with both methods of feeding.
3. Butter milk was found to have in this experiment about four-fifths the feeding value of skim milk.
4. In one test Poland Chinas and Berkshires gave similar returns, in another, Berkshires did better than Yorkshires.

POTATO DISEASES, ETC.

Owing to the remarkably dry weather of 1894, potatoes suffered less from fungus diseases than they have during any of the past five summers. The potato plots on our farm remained practically free from blights and rot. While this greatly reduced the gains from spraying with the various fungicides it gave an opportunity, unusual in Vermont, of studying the effects of these fungicides upon insects alone. The beneficial effects of some of these fungicides as deterrents against the flea-beetle were noted in the last report. This was even more strikingly shown in some of our plots this season, the gain in our earlier potatoes directly attributable to this effect being more than sufficient to repay all the costs of spraying. Grasshoppers proved unusually troublesome on our later plots, and here again Bordeaux mixture proved far more efficacious than did Paris green or any other chemical

tested. These results from the use of the Bordeaux mixture form an interesting and valuable supplement to the work of former seasons when its fungicidal value has been fully demonstrated.

The stronger solutions of the mixture have always given us the best returns, and as a result we are now recommending a little stronger mixture than heretofore for general use, viz: one containing about one pound of blue vitriol to seven and one-half gallons of water. No other fungicide tested proved equal to this mixture in some of its forms. The use of the ferrocyanide of potassium test in preparing the mixture offers some advantages, but our experiments indicate that the mixture thus prepared is not quite so efficacious as that containing a larger amount of lime.

The question is often asked by correspondents whether a large stock of the mixture cannot be made at the beginning of the season and kept for use as needed. Experiments with such a stock mixture indicate that it is inferior to that freshly prepared. The inconvenience of preparing the mixture have induced manufacturers to place some ready prepared mixtures and dry Bordeaux powders upon the market. Some of these were tested the past season and while the results are not conclusive they indicate their general inferiority to the freshly prepared mixture.

Potato scab ranks next to the late blight and rot as inimical to successful potato growing in this State. The use of corrosive sublimate for disinfecting the seed potatoes reduced the amount of scab and added as much as fifty per cent to our yield of marketable potatoes in one set of plots.

Experiments in one of the largest orchards in the State show conclusively the value of Bordeaux mixture in checking apple and pear scab. Four applications kept even the most susceptible varieties free from scab-spots and cracks, and added from 20 to over 100 per cent. to their market value. The keeping quality as well as the appearance of the fruit was greatly improved by the spraying.

Studies and experiments are under way upon certain grasses, especially our native Fowl Meadow grass, to determine its comparative value and adapabilty for cultivation in low land subject to overflow during spring freshets.

A number of threatening weed plants are invading the State, and studies are being made upon occurrence, means of dissemination and methods of eradication which will be published in due season.

EXPERIMENTS IN BEE KEEPING.

The experiments in this line were planned by and largely worked out under the direction of Messrs. O. J. Lowrey, M. F. Cram and H. W. Scott, a committee of the Vermont Bee Keepers' Association. The results of the year's work may be summarized as follows :

1. Several different sizes of frames were used. The results, however, were not sufficiently decisive to enable us to determine the best frames.

2. The honey made from bees fed with cane sugar syrup did not differ materially in composition from that adulterated directly with cane sugar.

Such as was made when the bees were fed but twenty pounds a week was somewhat more like normal honey than that made when the bees took twenty pounds a day. In each case some laevulose (honey sugar) was formed and a trace of acid added.

3. A test of the value of stimulative spring feeding gave unsatisfactory results and will be repeated.

4. The Langdon non-swarmer proved a failure.

5. Tests made seem to indicate that the winter temperature of the hives may vary without detriment to the bees.

FEEDING TESTS.

1. The results of a feeding test of Robertson mixture ensilage, a combination of corn, horse beans (entire plant) and sunflower heads, as compared with corn ensilage were given in the last (seventh) report. Owing to the slaughter of our herd the results were unsatisfactory. The experiment was therefore repeated during the winter of 1894-95. Neither ensilage kept well owing to imperfections in the silo. The losses of dry matter in the silo were, as usual, largely of a carbohydrate nature.

The cows did not eat the Robertson mixture ensilage quite as readily as that made from corn alone, leaving rather more orts. Two pounds less grain per 50 pounds of ensilage were fed with the Robertson mixture. There was a fifth less dry matter eaten with the Robertson mixture than with the corn ensilage. Essentially the same amounts of milk and butter were made on each, and the cows, if anything, gained in weight on the mixture feeding. It would appear then, that, in this test at least, the claims made for the mixture were upheld. Notwithstanding this favorable result, the Station does not feel justified in recommending the mixture unqualifiedly, because of the difficulty in getting satisfactory stands of the horse bean.

2. A short test was made of the relative feeding values of Robertson mixture and corn ensilages and roots (beets and carrots). The same weights of solids and fat, and nearly as much milk were made on the root ration as had been made three weeks earlier on the ensilages, at the expense, however, of eight per cent. more of dry matter. The solids not fat seemed to be decidedly increased by the change to roots. Such a change in the quality of milk is so peculiar, however, that we do not feel like laying stress upon it. On the whole the results of the two methods of feeding were about the same.

3. A test of the effect of "Nutriotone," a condimental food for milch cows and other animals, was carried out by a former officer of the station, who kindly places the results at its disposal. The test was carefully made and showed no beneficial results from the use of the material.

TESTS OF DAIRY APPARATUS.

Data was obtained at the fourth session of the Dairy School showing the relative efficiency of, power consumed by, and steam consumption of various makes of separators, being in continuation of similar tests made at previous

sessions and already reported. Five power and five hand separators were tried, full analyses of milks, skim milks, bowl slops, etc., made and losses located. The mechanical losses, as usual, were large. The churning, although at a slightly higher average temperature than that of the preceding session, was quite exhaustive. Omitting two churnings the average was 0.12 per cent fat in the butter milk.

Comparative trials of steam Babcock testers, manufactured by the Moseley & Stoddard Co., of Rutland, and the Vermont Farm Machine Co., of Bellows Falls, showed practically the same results in fat percentages, averages being, Stoddard 4.75 per cent, Farm Machine Co., 4.78 per cent. A long series of trials of the two against the Russian Babcock test averaged, steam turbine machines 5.18 per cent, Russian, 5.09 per cent. It is but fair to say, however, that recent comparisons of the steam Babcock with gravimetric tests (Adams' paper coil method) at this Station seem to indicate that the former may run from 0.02 to 0.05 per cent too high.

The "Lactanalyt," a new milk tester sold to quite an extent in some parts of the State, was tried and found unsatisfactory. Results were obtained agreeing fairly with the Babcock test in a few cases, but, as a rule, the figures were low of truth. Some of the details in the use of the apparatus seem open to criticism.

An interesting comparison of the steam consumption of the belt and turbine form of separators was made by Prof. A. W. Ayer, of the Mechanical Department of the University of Vermont and State Agricultural College. In the trials made the belt machine used but 86.3 per cent of the steam required by the turbine, while separating the same amount of milk. It is Prof. Ayer's judgment that "while the saving in steam by the belt machine might not be considered sufficient to warrant the extra expense of an engine if only one separator were to be used, I believe there should be no doubt as to the type of separators to be used if several of them were to be run in the same creamery, and that the belt machine in such cases should be chosen."

THE EFFECT OF FATIGUE UPON THE QUANTITY AND QUALITY OF MILK.

The advent of our new herd offered an opportunity to test the effect of fatigue upon cows. Half the cows gave richer milk the night of arrival and all gave richer milk the morning after arrival than they did two weeks later. The fat as usual was found to be the most variable constituent.

MISCELLANEOUS FODDER CROPS.

The extreme drought of 1894 seriously affected our tests of fodder crops. Soja beans, villous and spring vetches and serradella were all that came through with any sort of growth. The soja beans, and the two vetches, with and without oats, made fair growths. The seradella on the whole does not promise well. It is a slender, fine-leaved plant of low growth, well liked by cattle, but difficult to harvest and not yielding enough to warrant recommendation.

FOUR WAYS OF PRESERVING FODDER CORN.

An extended test of this matter was made in the winter of 1892-93, and published in our Sixth Report. The importance of the subject however warranted a repetition of the test. Some of the conditions were unfavorable in the first, some in the second tests, yet the main result has been the same in each case. The summarized results of the second trial are as follows:

1. Each of the four methods of preservation saved about four-fifths of the dry matter as harvested, and, judged by this alone, were of practically equal efficiency, the figures being: Stover ensilage and meal, 18 per cent loss of dry matter; whole ensilage, corn fodder, and corn stover and meal, 20 per cent loss of dry matter each. These figures are almost identical with those obtained in similar tests previously made at this Station.

2. The character of the losses in food ingredients is much the same in each case, there being little or no loss of crude ash or crude fibre, a shortage of about a tenth each of the crude protein, phosphoric acid and potash, while ether extract and nitrogen-free extract lose respectively two-tenths and three-tenths of the amount present at harvest.

3. The stooked fodders, while stooked, lost more and more dry matter as the winter went on; after cutting they lost considerable dry matter, but less as the winter advanced and temperatures were lowered.

4. The losses in gross weight and dry matter in the silos were found to be parallel, the latter, however, exceeding the former.

5. The ears in the silo lost more of their food value than those handled in other ways, the reverse of the result in the 1892-93 experiment.

6. The relative cost of placing the same amount of dry matter in the manger was greatly in favor of the whole ensilage. The time and money spent in husking and grinding the ears was wasted, since better results were obtained when the ears were left on the stalk.

7. In this experiment the ensilages were relished much better than the dry fodders, and the cows did better upon them.

8. The same quantities of milk and butter were made by feeding whole ensilage and stover ensilage and meal; the milk was not changed in quality; but the cows ate less dry matter from whole ensilage to produce the same amounts of milk and butter.

9. When a given amount of dry matter fed in the whole ensilage ration produced 100 pounds of milk and butter, the same amount of dry matter fed in the stover ensilages and meal rations produced but 91 or 92 pounds of milk and butter.

10. The whole ensilage lasted longest, and consequently made the most milk and butter. An acre of corn made into whole ensilage yielded as much as 1.095 acres made into stover ensilage.

11. The results of this experiment as a whole are in entire accord with those obtained in the similar trial at this Station in 1892-93, published in the Sixth report, pages 163-197.

Bulletin No. 42. Bovine Tuberculosis.

INTRODUCTION.

It has been the custom at this Station to reprint abstracts of bulletins issued during the year in the annual report, in order that their essential features might be put in more permanent form. In some cases the abstracts have been very brief, in others they have been practically reprints. Bulletin 42 on "Bovine Tuberculosis" was printed in a larger edition than any previous one except No. 26 on "Maple Sugar," yet it is nearly out of print. This fact, together with the importance of the subject, and the prominence which the disease has assumed in the public notice within the past year, prompts us to reprint the bulletin entire in this report.

The Station Veterinarian has made considerable further use of tuberculin as a diagnostic since the bulletin was issued, the total number of injections made by him (at date of writing) exceeding twenty-four hundred. The more recent data regarding its use in this State and a further discussion of the disease will be found on the pages following the reprint.

It should be noted that Act No. 102 of the Laws of 1894 printed below, provides for indemnity for cattle condemned and found tuberculous, and that the circular of the Cattle Commissioners (pp. 66-68) is no longer in force, also that the laws of Massachusetts, Connecticut, New York, Pennsylvania and perhaps other States as well as our own on this subject have been changed since the data given on pages 64-65 was compiled.

The dairymen of Vermont naturally looked to the Station for an intelligent candid statement of its investigations of tuberculosis and its detection. Its officers felt however the gravity of the subject and invited the assistance and advice of representative Vermont stockowners. The manuscript of the Bulletin was read by the Director of the Station at a joint meeting of the State Board of Agriculture (acting as Cattle Commissioners) and the Board of Control of the Station, and its subject matter was freely discussed. The proof sheets were submitted to the Governor and to the individual members of each Board for their comments and criticisms. Both Boards endorsed the Bulletin as being in their opinion a conservative statement of the present knowledge of the causes, prevalence and means of detection and prevention of tuberculosis.

No. 102.—AN ACT TO AMEND SECTIONS 4021, 4022 AND 4023 OF THE REVISED LAWS, RELATING TO DOMESTIC ANIMALS.

SECTION 1. Section 4021 of the Revised Laws is hereby amended to read as follows:

When bovine tuberculosis or any other contagious disease exists in the state among cattle or other domestic animals, the board of agriculture may quarantine all infected animals or such as they suppose have been exposed to the contagion, may prohibit any animal from passing on or over any of the highways near the place of quarantine, may enter upon any premises where there are animals suspected to have bovine tuberculosis or any contagious disease, may employ such expert help and

means as they deem necessary for the detection, prevention, treatment, cure and extirpation of such disease, but shall not apply the tuberculin test without the consent of the owner of the cattle, but in quarantine regulations against cattle imported from without the State the tuberculin test may be applied, and they may condemn and order killed any cattle or other domestic animals, believed by said board to be infected with bovine tuberculosis or any contagious disease, and may order the bodies of the same buried or burned, as in their judgment the case may require; may forbid the sale or removal from the premises of any dairy product from cows that are believed to have bovine tuberculosis. Any person who shall knowingly violate or refuse to comply with any order or regulation of such board, made under the authority of this section, shall be fined not more than two hundred dollars, or be imprisoned not more than two years or both.

SEC. 2. Section 4022 of the Revised Laws is hereby amended so as to read as follows:

If any person shall sell or offer to sell any cattle or other domestic animal known to him to be infected with bovine tuberculosis or any contagious disease, or any disease dangerous to the public health, or shall sell or offer to sell any part or parts of such cattle or other domestic animal, he shall be fined not more than two hundred dollars or be imprisoned not more than two years or both.

SEC. 3. The value of all cattle or other domestic animals, killed by the written order of the board of agriculture, shall be appraised by one of said board and a disinterested person selected by the owner of the condemned animals, but if these two cannot agree upon the amount of the appraised value of the animal, they shall select a third disinterested person, who together with them shall appraise the animal, such appraisal to be made just before killing, and on a basis of health. The limit of appraisal of cattle shall be forty dollars. A post-mortem examination shall be made, and if the animal be found affected with bovine tuberculosis, or any disease dangerous to public health, the owner of the animal shall receive one-half the appraised value; but if no bovine tuberculosis or disease dangerous to public health be found, the owner of the animal shall receive the full amount of the appraisal, and in addition shall receive the slaughtered animal. The amount which the owner is entitled to receive shall be paid by the State to the owner of such animal or animals upon a written order, signed by the member of the board in charge, and countersigned by the secretary of said board. No indemnity shall be paid to the owner of condemned cattle or other domestic animals that have not been owned and kept in the State for at least six months previous to the discovery of the disease. Any person who shall knowingly violate or refuse to comply with any regulations made by such board of agriculture, under the authority and provisions of this section, shall be fined not more than two hundred dollars, or imprisoned not more than two years, or both.

SEC. 4. All expenses incurred by the board under the provisions of this act shall be allowed by the State auditor, upon the approval of the Governor, and paid by the State.

Approved November 27, 1894.

Bulletin No. 42. Bovine Tuberculosis,

BY J. L. HILLS AND F. A. RICH, V. S., M. D.

I. SUMMARY.

II. Tuberculosis was discovered in the Station herd in January last by means of the tuberculin test. But two cows were out of condition, yet twenty-four animals reacted at this and subsequent tests. The infected animals were killed, and the post-mortems confirmed the test throughout, while two animals which did not react showed no disease upon slaughter. The distribution of the disease was: Lungs, 90 per cent., udder and its glands, 73 per cent., intestines and mesenteric glands, 50 per cent. Physical examination alone did not detect disease in several cases. Six of the cattle were brought from herds which we now believe were affected with tuberculosis. The disease was located at each end of the barn. The barn was disinfected by burning sulphur and by spraying a dilute solution of corrosive sublimate over the wood work. All the wood about the mangers was replaced. Eighteen grade Jerseys were bought in April from seven different herds, subject to the tuberculin test. All were found free from disease. It is intended hereafter to periodically test the Station herd with tuberculin. (Pages 21-30).

III. The Station Veterinarian has this year made over a thousand injections of tuberculin, mostly in this State. 222 animals were found diseased, 220 were slaughtered and found tuberculous. Omitting two badly infected Vermont herds, but 39 animals were tuberculous out of 662 tested, in 81 different herds. These figures should not be taken as indicating the prevalence of the disease in this State for injections were made mainly in suspected herds. The distribution of the disease in 139 post-mortems showed 82 per cent. in the lungs, 22 per cent. in the mesenteric glands and 24 per cent. in the udder. (Pages 30-31.)

IV. 1. PREVALENCE AND HISTORY.--Tuberculosis is the general name for a class of diseases which attack various organs and which both man and animal readily contract. The human death rate from all forms of the disease is about one in four. Cattle are affected in various proportions in different parts of the world. The extent of bovine tuberculosis in this country cannot be accurately stated owing to the lack of systematic inspection. The disease has been known from antiquity both in man and animal. (Pages 32-33.)

2. CAUSE.--The sole and exciting cause of this disease is a germ called the bacillus tuberculosis. It is a parasitic, microscopic, rod-shaped plant which lives in the animal body, has great vitality, resists heat, cold, moisture, drought, decay and often the process of digestion. It is killed by boiling, by long continued heat at from 150 to 170°, as well as by sunlight, air and certain chemicals. Infection occurs: (1) By breathing the germs; (2) By swallowing the germs; (3) By their entrance through a cut or wound. The main sources of infection are: (1) The dust of the dried spittle of consumptives or other tuberculous matter, either breathed or swallowed; (2) Contact with tuberculous material or people; (3) The meat and milk of tuberculous animals. (Pages 33-36.)

3. ACCESSORY CAUSES.--The bacillus tuberculosis is the sole cause of the disease, but there are conditions so favorable to its development that they are well termed accessory causes, although strictly speaking they are not casual. Among these conditions are: (1) Hereditary predisposition; (2) Unhealthy surroundings, poor ventilation, uncleanly, dark, damp, hot and cold stabling, soiling system, lack of exercise, climatic influences; (3) Faulty feeding, under feeding, over feeding, feeding on unwholesome or indigestable materials, over production; (4) Faulty breeding, in and inbreeding, early, late and frequent breeding, intensive breeding, lack of constitution; (5) Ill-health, temporary predisposition; (6) Physical conformation. (Pages 36-41).

4. SYMPTOMS.--The symptoms of bovine tuberculosis are more obscure than those of the human disease, and often baffle detection. Any attempt to describe them would probably prove misleading rather than instructive. (Page 41.)

5. LESIONS.--Whenever the germs locate in the body they irritate the tissue, forming round nodular masses. These newly formed tubercles are usually soft and red. In chronic cases they become cheesy, limy, and disintegrate and run together, forming yellowish, caseous, pus-containing masses of various sizes imbedded in the diseased organs. The lungs, linings of the chest and abdomen, the lymphatic glands and the bowels are most often diseased. Sometimes the tubercles are too small for the naked eye to see. (Pages 42-45.)

6. THE TUBERCULIN TEST.--Tuberculin is made from pure cultures (growth separate from all other germs) of the tubercle bacillus, concentrated, sterilized (to kill all germ life) and filtered. It contains the chemical poisons created by the life functions of the germs. Although a failure as a cure for tuberculosis, it has been successfully used to detect its existence in cattle. If a small quantity is injected into a tuberculous animal it will produce a fever, but, if the animal is healthy and it is properly used there should be no rise of temperature. An increase of two degrees above the normal temperature after injection is ground for suspicion. The tuberculin test is not infallible. Mistakes have been made in its use, and it has sometimes failed in careful hands. It is, however, much more reliable than any other known means of diagnosis. If properly made and used, it cannot cause tuberculosis. (Pages 45-51.)

7. INTER-RELATION.--Both human and bovine tuberculosis are infectious. Human tuberculosis affects the lower animals, and bovine tuberculosis affects man. The latter has never been directly proved, but many cases of accidental infection have demonstrated its possibility. It has been claimed that tuberculosis does not exist where there are no cattle, and that tuberculous infection was originally of bovine origin. Experiments have shown that the disease producing germ may be present in the milk whether the udder is affected or not. If milk is sterilized by heat, or "pasteurized," it may be considered safe to use. It has recently been claimed that, because of the alleged presence of tuberculin in tuberculous milk, even though sterilized, there is danger to its consumers of aggravation of the disease if already present. It is not advisable to attempt to cure bovine tuberculosis. (Pages 51-61.)

8. PREVENTION.--Both human and bovine tuberculosis are preventable, and the means which may be taken to prevent its spread are: (1) Official inspection of cattle, meat and milk; (2) The destruction or disinfection of human spittle; (3) Careful disinfection of places occupied by tuberculous men or animals. The stock owner, so far as possible, should keep his cattle under healthy conditions, should keep each animal in its own stanchion, should isolate suspected animals, should buy cautiously, should exclude human and animal consumptives from the barn, should test newly admitted animals, and, if he finds the disease, should kill, bury or burn the diseased animals, disinfect the premises and test the rest of the herd. (Pages 61-62.)

9. RELATION OF THE STATE TO TUBERCULOSIS.--The most successful work in the suppression of animal disease is that done by the Government, since it accomplished in a systematic, intelligent and thorough manner. The New England, Middle and some of the Western States exercise a control over animal diseases by means of Cattle Commissions. Some State laws permit indemnity, others do not. Attention is called to the statement and bond of the Vermont Commission on pages 66-68 of this bulletin. (Pages 63-68.)

II. TUBERCULOSIS IN THE EXPERIMENT STATION HERD.

Dairying has always been a prominent feature of the work of this Station. Beginning in June, 1888, with six cows, the Station herd was increased by purchase and by breeding until at the opening of the current year it consisted of thirty-three head, including three bulls, twenty-four cows, one yearling and five calves. There were twenty-one Jerseys (five registered), six Ayrshires (four registered) and six Holsteins (five registered) in the herd. The sixteen unregistered Jerseys were mostly high grades. Ten of the cows were members of the herd of the summer of 1891, seven were bought that fall, and seven, together with the three bulls, were bought later.

The herd records for 1892* and 1893† were very satisfactory. In 1892 the twelve regular members of the herd averaged 351 pounds of butter per cow, while in 1893, the fifteen regular members average 341 pounds of butter per cow. If the irregular members of the herd are included these averages are reduced to 334 pounds for 1892 and 311 pounds for 1893. The decrease in the production of 1893 was partly due to abortion and sterility, possibly of tubercular origin. The herd was a good working dairy, such as is within the means of most dairymen. It was collected without large outlay, only four of the cows costing over one hundred dollars. We hoped to obtain good butter yields by care and feed rather than by buying costly stock.

At New Year's the entire herd seemed to be in prime condition, with the exception of the registered Jersey cow LaViolette 3rd, 62,543 A. J. C. C. and the registered Holstein cow Mercedes Jonkje, 18,346 H. F. H. B. These two cows began to appear unthrifty on coming in from pasture in the late fall. The Jersey coughed somewhat. The Station Veterinarian made a physical examination of the two cows and diagnosed either acute bronchitis or tuberculosis. A general physical examination of the other cattle indicated the presence of considerable lung disease, and it was decided to use Koch's test (injection of Koch's lymph or tuberculin) upon the entire herd.

The detection of tuberculosis in its earlier stages by external signs is usually impossible. Unless the lesions are in the lungs, even advanced cases are hard to detect. An animal in this condition may be sleek, fat and frisky, may give large amounts of apparently normal milk, and yet may be infecting other stock as well as those using her milk. It is obviously desirable to be able to detect the presence of this disease in any stage, early or late, wherever its location, without injury to the healthy animal. The means for such detection have been found in the fluid known as Koch's

* See Sixth Annual Report, p. 120; also Bulletin No. 33; also Seventh Annual Report, now in press.

† See Seventh Annual Report, now in press.

lymph or tuberculin, a preparation first discovered in 1889 by the famous German scientist, Dr. Koch. He vainly hoped it might prove a cure for tuberculosis. Although a failure as a remedy, it is rapidly coming into use for diagnostic purposes in veterinary practice.

The "test" is made as follows:

(1) The normal temperature of the animal is taken.

(2) A small quantity of dilute lymph is injected under the carefully disinfected skin near the shoulder blade.

(3) The temperature of the animal is taken at intervals of from one to three hours, beginning with the sixth hour from the time of injection and continuing until the sixteenth to twenty-fourth hour.

If an animal is tuberculous, a decided rise of temperature or temporary fever is observed, usually in from six to fourteen hours. Although not infallible, this test is much the most reliable test we now have. *It should be used only by skillful veterinarians, since the precautions necessary are not such as the farmer is prepared to observe.**

The tuberculin used in the test at the Experiment Station was procured from the Bureau of Animal Industry of the Department of Agriculture at Washington. The injections were made by the Station Veterinarian and the temperatures taken under his direction.

The twenty-four cows were injected December 31, between ten and twelve p. m., the temperature of each cow was taken at the time of injection and hourly on the day following from 8 A. M. to 11 P. M., and again January 5, from 8 A. M. to 12 P. M. The amount of tuberculin used per animal were: Bulls, 3 c. c.; cows, 2 to 2.5 c. c.; yearling, 1.5 c. c.; calves, 0.75 c. c.

The following table shows in detail the temperature observations on each of the thirty-three animals. The normal temperatures occupy the upper lines, and those taken after injection, the lower line. The temperatures indicating reaction are put in black faced type. The following cows did not react: Bonnie, Blossom, Dinah, Gretchen, Josie, Minerva and Rena Myrtle. They were driven to an uninfected barn. Dorothy and Lolita showed single temperatures above 104° and were isolated in the veterinary hospital. On March 25th, eight of these cows were again tested, and one, Bonnie, reacted. The second test is entered in the table in each case below the first test. Bonnie was tested a third time, June 28, and again reacted.

As will be seen on reference to the table, the three bulls, sixteen cows, the yearling and one calf, a total of twenty-one animals, being nearly three quarters of the adult herd, reacted to tuberculin. Fifteen of these showed physical signs of lung disease; two others had bronchitis.

*For more extended explanation of the detection of tuberculosis and the use of tuberculin see pages 41 to 51.

RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS.

	8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 M.	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.	9 P. M.	10 P. M	11 P. M.	Average Normal.	Highest Normal.	Highest Test Temperature.	Rise of Highest Test above Average Normal.	Rise of Highest Test above Highest Normal.
1. Louis Lambert, 25371	100.5	101.5	101.	100.5	101.	100.5	100.8	100.5	100.8	100.5	100.5										
	103.5	103.	**104.**	**105.**	**105.5**	**105.5**	**105.5**	**105.**	**105.5**	**105.**	**105.3**	**104.5**	**104.**	103.8			100.7	101.5	**105.5**	**4.8**	**4.0**
2. Beauty	102.	102.	101.4	101.6	101.6	102.	102.	101.6	101.6	101.8		101.5		101.5		100.5					
	101.8	102.8	102.6	103.5	**105.5**	**106.3**	**106.3**	**105.3**	**106.5**	**105.6**	**105.4**	**105.4**	**105.2**	**104.8**	**104.**	103.	101.6	102.	**106.5**	**4.9**	**4.5**
3. Blossom	102.	101.8	101.5	101.8	101.5	101.5	101.6	101.8	101.6	101.6		100.8		100.8		100.8					
	102.2	101.8	102.	101.8	102.	101.	101.	101.5	102.	102.	101.6	101.5	101.	101.	101.	101.	101.5	102.	102.2	0.7	0.2
Blossom	100.		100.6		101.5		100.2		100.		101.5		100.5		101.5						
	101.2		101.4		102.5		102.2		102.2		102.		102.5		100.8		100.7	101.5	102.5	1.8	1.0
4. Bright Eyes	102.4	101.5	101.8	102.	102.4	103.	102.3	102.6	102.8	102.4		101.5		102.6		100.2					
	103.	102.6	102.5	102.2	102.	103.6	**104.8**	**104.5**	**105.**	**104.**	103.8	**104.**	**104.**	**104.**	103.5	103.2	102.1	103.	**105.**	**2.9**	**2.0**
5. Dorothy	101.	102.	101.6	102.	102.2	102.2	102.	102.5	102.2	102.2		101.2		102.		102.					
	102.5	103.2	102.6	102.4	102.2	102.	102.8	102.8	103.	103.3	**104.2**	103.	103.	103.	102.5	102.5	102.	102.5	**104.2**	2.2	1.7
Dorothy	101.		100.6		101.		101.		101·		101.2		101.5		102.2						
	102.5		102.5		101.5		101.5		102.3		102.5		102.				101.2	102.2	102.5	1.3	0.3
6. Floss	102.6	102.4	101.5	102.	102.2	102.	102.5	102.4	102.2	102.		102.2		102.2		102.					
	103.8	103.8	**104.8**	**104.8**	**105.6**	**105.2**	**108.5**	**106.8**	**107.**	**106.**	**106.**	**106.**	**106.**	**105.5**	**105.**	**104.**	102.2	102.6	**107.**	**4.8**	**4.4**
7. Gretchen	100.5	101.	101.	101.2	101.	101.	101.	101.	101.	101.		101.		101.		101.					
	101.8	102.	102.	101.8	101.8	102.	102.	102.	101.5	102.5	102.5	103.3	102.	102.	102.	101.5	101.	101.2	102.5	1.5	1.3
Gretchen	100.		101.		101.		101.		101.		101.		101.2		100.2						
	101.6		101.		100.8		100.4		100.		100.2		100.8		100.		100.8	101.2	101.6	0.8	**0.4**

RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS.

	8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 M.	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.	9 P. M.	10 P. M.	11 P. M.	Average Normal.	Highest Normal.	Highest Test Temperature.	Rise of Highest Test above Average Normal.	Rise of Highest Test above Highest Normal.
8. Josie	101.6	101.6	101.6	101.2	101.	101.2	101.2	101.5	101.1	101.6		101.2		101.3		100.8					
	101.2	102.6	101.2	101.	101.5	101.5	101.8	101.8	102.	101.2	101.6	101.2	101.2	102.5	101.8	101.0	101.8	101.6	102.6	1.3	1.0
Josie	99.4		99.2		100.5		101.		101.6		101.4		99.8		101.2						
	101.		101.4		101.8		101.5		101.		101.4		102.0		101.0		100.5	101.6	102.	1.5	0.4
9. La Violette, 3d, 62,543	104.	104.	104.	104.	103.6	104.	104.	104.2	104.4	104.1		103.5		103.6		103.0					
	104.5	105.	105.	105.	104.4	105	104.8	104.8	104.2	103.2	103.2	102.6	102.8	102.5	102.5	103.0	103.4	104.4	105.	1.6	0.6
10. Marguerite	101.6	101.8	101.6	101.5	102.	103.	102.	101.8	102.	102.		101.8		101.5		100.5					
	102.	102.6	102.	102.	103.4	102.5	102.	103.	103.5	104.	104.	104.8	104.	104.5	104.0	104.	101.8	103.0	104.8	3.	1.8
11. Marburi 2d, 65,043	101.5	101.6	101.6	101.	101.	101.5	101.6	101.2	101.6	101.6		101.		101.2		100.0					
	101.4	101.	102.	102.4	103.	104.5	105.8	105.5	104.5	103.	102.	101.5	101.4	101.0	101.4	102.6	101.3	101.6	105.8	4.5	4.2
12. Martha	101.8	101.6	101.6	101.5	101.5	101.5	102.	101.5	101.5	101.4		101.6		101.4		100.2					
	101.5	101.6	102.	101.4	102.	102.2	103.3	103.3	106.5	105.6	105.4	105.4	105.2	104.8	104.0	103.0	101.5	102.0	106.5	5.	4.5
13. Minerva	101.5	101.5	101.6	101.6	101.4	101.	101.	102.	101.6	101.6		101.		101.0		100.2					
	100.2	100.8	100.5	101.	101.4	101.5	101.5	101.	101.3	101.5	101.5	101.5	101.5	101.5	102.0	101.5	101.3	102.0	102.0	0.7	0.0
Minerva	98.6		99.		99.		99.8		100.8		99.4		98.5		100.2						
	100.5		100.4		101.2		102.5		101.8		102.5		102.2		100.4		99.4	100.8	102.5	3.1	1.7
14. Myrtle	101.5	101.5	101.4	101.4	101.	101.	101.4	101.4	101.6	102.		101.		101.5		100.8					
	102.	102.4	104.	106.2	107.	107.	107.	107.	106.8	105.2	105.	105.8	105.5	105.	105.	104.2	101.3	102.0	107.	5.7	5.
15. Nancy	101.5	101.6	101.	101.	101.2	101.	101.2	101.2	101.2	101.4		101.		101.3		100.2					
	102.5	102.	101.5	102.	102.6	104.	104.8	104.5	105.	105.4	105.2	105.5	105.5	104.	103.5	103.3	101.1	101.6	105.5	4.4	3.9
16. Sadie's Delight, 53,392	101.2	101.2	101.	101.	101.2	101.	101.	101.	101.	101.2		101.8		102.8		100.8					
	101.	103.8	104.6	107.5	107.4	106.8	105.5	105.5	105.5	103.	102.6	103.	102.5	102.5	102.0	101.5	101.2	102.8	107.5	6.3	4.7

RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS AND AYRSHIRES.

		8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 M.	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.	9 P. M.	10 P. M.	11 P. M.	Average Normal.	Highest Normal.	Highest Test Temperature.	Rise of Highest Test above Average Normal.	Rise of Highest Test above Highest Normal.
17.	Ethel	101.4	101.5	101.4	101.8	101.6	102.	101.6	102.2	102.	101.8	101.6	102.	102.	101.8	101.8						
		101.5	102.2	102.6	103.4	**104.4**	**105.**	**105.2**	**105.2**	**104.6**	**104.**	103.2						101.8	102.2	**105.2**	**3.4**	**3.**
18.	Calf 1	101.8	101.5	102.5	102.	101.5	101.3	101.5	102.	102.	102.5	102.5										
		102.5	102.	102.3	102.3	101.5	102.	102.3	102.	102.5	102.	102.	101.5	101.3	101.	101.		101.9	102.5	102.5	0.6	0.0
19.	Calf 2	101.5	101.8	101.5	102.	102.5	102.	101.8	102.	101.8	102.2	102.5										
		102.5	102.3	103.	102.3	102.	102.	102.	102.5	102.3	101.8	101.5	102.	101.5	101.3	102.5		102.	102.5	103.	1.0	0.5
20.	Calf 3	101.	101.	101.5	101.5	102.3	102.5	102.5	102.	102.	102.8	102.8										
		101.5	102.5	103.8	102.5	**104.**	**104.**	**104.**	103.2	103.3	103.	103.	103.5	103.	102.5	102.		102.	102.8	**104.**	**2.0**	1.2
21.	Calf 5	101.3	101.3	101.	101.5	101.3	101.5	101.5	101.5	101.5	101.8	102.										
		103.	102.5	102.8	102.6	102.8	103.	102.	102.5	102.5	103.	102.	103.	101.8	101.8	101.8		101.5	102.	103.	1.5	1.0
22.	Rubinor, 4676.	100.8	100.5	100.5	101.	100.8	101.3	101.5	101.5	101.5	101.	100.8										
		101.	101.	101.8	101.8	102.5	103.	**104.**	**105.5**	**106.**	**106.**	**106.**	**105.5**	**105.**	**104.5**	103.	103.	101.	101.5	**106.**	**5.0**	**4.5**
23.	Bonnie	101.5	101.6	101.4	101.5	101.4	101.5	101.	101.	101.2	101.4		101.		102.		100.8					
		102.2	101.5	101.8	101.5	101.6	103.	102.3	102.2	103.	103.	102.	102.8	103.5	103.5	103.3	103.5	101.3	102.	103.5	**2.2**	1.5
	Bonnie	98.6		101.1		101.		100.8		99.6		101.5		101.								
		100.6		**104.4**		**106.**		**105.9**		**105.2**		103.8		**105.**		**104.5**		100.5	101.5	**106.**	**5.5**	**4.5**
24.	Creamer	102.	103.	103.2	102.5	102.6	102.5	101.5	101.5	102.5	102.		102.		102.		100.8					
		103.5	103.5	103.6	**104.2**	103.	**106.**	**106.6**	**107.**	**107.3**	**107.**	**106.8**	**105.5**	**105.3**	**105.**	**104.8**	**104.8**	102.2	103.2	**107.3**	**5.1**	**4.1**
25.	Lolita, 9465	102.5	103.	102.8	103.	103.	103.	103.5	103.2	103.4	103.2		100.		100.		100.					
		102.5	102.8	102.8	102.8	102.8	103.2	103.4	102.8	103.5	**104.5**	103.	103.5	103.6	103.5	103.3	103.3	102.4	103.5	**104.5**	**2.1**	1.0
	Lolita, 9465	101.		101.8		101.8		101.		101.2		101.		102.2		100.6						
		102.5		102.5		101.5		101.5		101.8		102.5		102.5				101.3	102.2	102.5		0.3

RECORDS OF TUBERCULIN TEST, STATION HERD, AYRSHIRES AND HOLSTEINS.

	8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 M.	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.	9 P. M.	10 P. M.	11 P. M	Average Normal.	Highest Normal.	Highest Test Temperature.	Rise of Highest Test above Average Normal.	Rise of Highest Test above Highest Normal.
26. Rena Myrtle,	102.2	102.6	102.5	101.	102.	101.6	101.7	101.6	101.6	101.6		101.		101.		100.5					
9530.	102.	102.2	102.2	102.5	102.	102.	101.8	102.	102.	102.	101.8	101.8	101.8	101.8	101.3	101.3	101.7	102.6	102.5	0.8	-0.1
Rena Myrtle,	101.5		101.6		101.8		100.8		100.4		101.6		100.8		101.4						
9530.	101.2		102.2		102.2		102.		101.5		101 8		102.		101.6		101.2	101.8	102.2	1.0	0.4
27. Calf 4	102.8	102.5	102.	102.8	102.	102.	102.	102.	102.	102.5	102.5										
	103.	102.5	102.8	102.5	102.8	102.5	102.8	102.5	102.8	102.3	102.	102.	102.	102.	101.8		102.3	102.8	103.	0.7	0.2
28. Marmion	101.	101.	101.	100.8	101.3	100.5	101.5	101.	101.	101.3	101.3										
	106.5	**106.**	**106.**	**106.5**	**105 8**	**105.8**	**105.5**	**105.5**	**105.5**	**106.**	**106.3**	**106.**	**106.**	**106.**	**105.**		101.1	101.5	**106.5**	**5.4**	**5.0**
29. Cigarette,	102.4	102.2	102.2	101.6	102.	102.2	102.	101.6	101.5	102.		101.2		102.		101.5					
3886.	103.	103.	103.5	103.5	**104.5**	**104.5**	**105.5**	**106.**	**106.**	**105.3**	**105.**	**105.**	**104.3**	**104.**	**104.**	103.	101.9	102.5	**106.**	**4.1**	**3.5**
30. Cloverette,	102.	102.2	102.	102.	101.6	102.	102.	102.	101.8	102.		101.4		102.		101.2					
23286.	102.	102.5	103.6	103.5	**104.**	**104.5**	**105.5**	**196.8**	**106.5**	**107.**	**106.**	**106.3**	**106.**	**106.**	**105.3**	**104.5**	101.9	102.2	**107.**	**5.1**	**4.8**
31. Dinah	102.	102.	101.8	102.5	102.	103.	102.5	102.5	102.2	102.4		102.6		102.4		100.8					
	102.	102.	102.5	103.	102.8	103.5	103.2	102.5	103.	103.	103.4	102.2	103.	102.5	103.	102.4	102.2	103.	103.5	3.1	0.5
32. Mercedes	102.	102.	102.2	102.2	102.5	102.	102.	102.	102.	102.2		102.		102.		102.					
Jonkje, 18346.	102.2	103.	103.6	103.8	103.8	**106.**	**105.8**	**106.2**	**106.2**	**106.5**	**104.5**	**104.4**	**104.5**	**104.**	**104.**	103.5	102.1	102.5	**106.5**	**4.4**	**4.0**
33. Pipchin 2d,	102.	102.	102.2	101.5	101.	101.	101.	101.5	101.	101.		101.		101.		100.8					
1483.	103.5	103 6	**105.**	**107.**	**107.5**	**107.5**	**107.8**	**106.5**	**106.5**	**105.8**	**103.6**	**104.**	103.6	**104.**	**104.**	103.6	101.3	102.2	**107.8**	**6.5**	**5.6**

1-21 Jerseys, 22-27 Ayrshires, 28-33 Holsteins. Registered animals have registered numbers attached. 18, 27 and 28 were eligible to registry.

The Board of Control of the Station were notified at once, and all sales of farm dairy products were stopped. After a thorough discussion of the situation, and after consultation with Dr. J. H. Hamilton, President of the State Board of Health, the State Board of Agriculture‡, Hon. Z. A. Gilbert of Maine and Hon. A. W. Cheever of Massachusetts, Ex-members of the Cattle Commissions of their respective States, and Dr. Frank H. Miller, V. S., of Burlington, the Board of Control ordered the slaughter of three cows, La Violette 3d, Mercedes Jonkje and Creamer. The two former were manifestly out of conditon, while Creamer was in as fine flesh as any cow in the herd.

The post-mortems were conducted in the presence of the above named officials, and Dr. H. A. Crandall, City Health Officer, by the Station Veterinarian, assisted by Drs. F. H. and G. A. Miller, veterinary surgeons. LaViolette and Mercedes were plainly and badly tuberculous, the evidence being clear to the naked eye. Creamer's udder contained miliary tubercles, which upon microscopic examination† showed the characteristic bacteria (bacillus tuberculosis). Later developments showed that the lesions in her case were more obscure than those of any other animal killed in the herd.

The rest of the cattle reacting to the lymph were killed, and post-mortems made. In every case the prediction of the tuberculin was verified. Two calves (Nos. 2 and 5) which did not react were killed and examined with scrupulous care, but no evidences of the disease were found.

The lesions found in the animals killed were, briefly, as follows:

1. JERSEYS—*Bull: Louis Lambert**; lung contained caseous masses; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; left testicle calcareous.

2. *Cows: Beauty**; apex one lung, caseous, calcareous; bronchial and post-pharyngeal glands enlarged, caseous, calcareous.

4. *Bright Eyes**, Bronchial and post-pharyngeal glands greatly enlarged, caseous; liver and capsule tubercular; supermammary glands tubercular.

6. *Floss**; lung contained caseous masses extending well into parenchyma; bronchial and post-pharyngeal glands enlarged, caseous.

9. *La Violette***; lungs consolidated, outer surface mottled, section showed pus cavities, caseous; pleura and pleural side of diaphragm thickly studed with tubercles; bronchial, mesentric and lymphatic glands in general tubercular, caseous. Apparently an acute form of tuberculosis.

10. *Marguerite**; apex lung caseous; bronchial, post-pharyngeal and supermammary glands tubercular.

‡This board is also the State Cattle Commission.
†By Dr. J. H. Lindsley, Pathologist of Med. Dept., Univ. of Vt., and State Ag'l College.
*Physical signs of lung disease.
**Bronchitis and unthriftiness.

11. *Marburi 2d*;* post-pharyngeal glands tubercular; supermammary glands enlarged and tubercular; indurated mass in right fore quarter.

12. *Martha*;* bronchial, mesenteric and supermammary glands tubercular; peritoneum over uterus contained tubercles.

14. *Myrtle*;* lungs contained large caseous masses; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; supermammary glands enlarged, tubercular.

15. *Nancy*;* Pleurisy with adhesions; bronchial, post-pharyngeal and mesenteric glands tubercular.

16. *Sadie's Delight*;* lungs contained pus and caseous masses; plastic pleuritis with adhesions; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; supermammary and mesenteric glands tubercular.

17. *Yearling, Ethel;* post-pharyngeal glands enlarged, caseous, calcareous; miliary tubercles on mesentery.

20. *Calf No. 3*, (2½ months old); lungs contained caseated tubercular nodules; bronchial and mesenteric glands tubercular. This calf, with four others, had been fed on skimmilk from Station herd. Its mother (Josie) did not react to tuberculin.

22. AYRSHIRES—*Bull: Rubinor*; apex one lung caseous; bronchial and post-pharyngeal glands enlarged, caseous.

23. *Cows—Bonnie;* passed first injection; gave reaction on second and third tests; lungs and lymphatic glands tubercular.

24. *Creamer;* mesenteric glands enlarged, indurated, highly pigmented; supermammary glands enlarged with udder tubercular. Foetal calf (8½ mos.) normal and healthy.

28. HOLSTEIN—*Bull: Marmion*;* bronchial and post-pharyngeal glands enlarged, caseous, calcareous.

29. *Cows—Cigarette*;* lungs contained pus, caseous; bronchial glands not enlarged but caseous, calcareous; mesenteric glands tubercular; supermammary glands greatly enlarged and udder indurated, both tubercular.

30. *Cloverette;* supermammary and mesenteric glands tubercular; some of latter contained caseous matter.

32. *Mercedes Jonkje**;* outer surface lungs mottled with aggregations of tubercles, section showed hyperplasia of interlobular tissue, with little consolidation and no cavities; pleura studded with tubercles; spleen mottled, tubercular; supermammary, superficial inguinal and mesenteric glands all enlarged, tubercular.

33. *Pipchin 2nd*;* lungs filled with tubercular deposits; pleura, pleural side of diaphragm and pericardium studded with tubercles: pleurisy with adhesions; bronchial and post-pharyngeal glands greatly enlarged, calcareous; supermammary and mesenteric glands tubercular; uterus filled with tubercles; ovaries tubercular. Cow had been sterile nearly two years.

* Physical signs of lung disease.
** Bronchitis and unthriftiness.

Calves Nos. 2 and 5, no indications of tuberculosis. These calves did not react to tuberculin, and were killed as check to test.

The distribution of disease was as follows:

Lungs, bronchial and post-pharyngeal glands,	90	per cent.
Udder and supermammary glands,	73	"
Intestinal and mesenteric glands,	50	"

The post-mortems confirmed the tuberculin test without exception. Physical examination alone failed to reveal the presence of the disease in a number of cases.

The previous history of the cattle is interesting. Six were bought from herds which we now have reason to believe were more or less affected with tuberculosis; three were out of tuberculous Station cows; three were out of non-tuberculous Station cows; one four-year-old healthy cow is out of a tuberculous mother. The cows usually stood in the same stanchions without material change, the Jerseys at the west end, Ayrshires in the middle and Holsteins at the east end. It is interesting to note the location of the diseased cows in the barn. Omitting one cow which had been in the herd but two months, the west seven cows were all diseased; of the next seven, only one was diseased January 1st, although one (Bonnie) developed it later. All of the east five cows were tuberculous. The two ends of the line were diseased, the middle was comparatively free. This would indicate that the primal sources of infection were at the ends of the line. The bulls had been constantly exposed to the disease, since they were fed upon the orts left by the cows. Notwithstanding this, the lesions in the bulls were mainly in the lungs and thoracic glands. It seems probable that the defective ventilation of the barn and the watering device—open buckets in front of the stanchions—aided in the dissemination of the disease. The buckets have been removed and the system of ventilation is being modified.

After the slaughter of the diseased animals, the healthy cows were removed to another barn, and the stable was thoroughly washed with hot water. Following this, every square inch of wood work was sprayed and washed with a solution of corrosive sublimate (1 to 1000) and then 125 pounds of sulphur was burned in the tightly closed stable and cellar. This being done, all the wood work of the mangers and in front of the stanchions was torn out and replaced with new, after which the double sterilization with corrosive sublimate and sulphur was repeated.

About the middle of April, eighteen grade Jersey cattle were purchased at $50 per head from seven herds in Orange County, subject to the tuberculin test. The results of this test are shown in the following table:

	Normal Temperature at Injection. April 16. 10 P. M.	After Injection, April 17.						Highest Test Temperature.	Rise of Highest Test Temperature over Normal.
		8 A.M.	9 A.M.	12 M	2 P.M.	4 P.M.	6 P.M.		
Julia	101.	101.6	101.6	101.5	101.4	101.2	101.	101.6	0.6
Flora*	105.5	102.6	103.8	104.	104.1	104.4	104.5	104.6	—1.
Fanny	101.4	101.6	101.5	101.8	101.6	101.6	101.8	101.8	0.4
Jessie	101.4	100.8	102.	101.5	101.5	101.4	101.2	102.	0.6
Fairie	101.8	101.8	102.	102.	102.2	102.2	102.	102.2	0.4
Dandelion	100.5	101.6	101.6	101.4	101.4	101.	100.6	101.6	1.1
Jennie	100.8	101.	101.2	101.2	101.2	100 8	101.6	101.6	0.8
Belle Black	101.	101.4	101.	101.	101.	100.6	100.8	101.4	0.4
Violet	100.6	101 8	102.	102.	101.8	101.8	100.6	102.	1.4
Bess	101.4	101.6	101.6	102.2	101.4	101.4	101.6	102.2	0.8
Dora	100.8	100.8	100.6	101.	100.6	101.4	101.1	101.4	0.6
Red Top	100.6	102.	102.4	102.2	102.	102.4	101.6	102.4	1.8
Clover	101.6	102.2	102.	101.8	101.6	101.2	103.2	102.2	0.6
Brownie	101.6	102.	101.4	101.2	101.2	101.	101.2	102.	1.4
Maizie	101.4	101.2	101.	101.	100.6	100.6	101.2	101.2	—0.2
Golden Rod	101.2	101.2	101.2	101.	101.	101.	101.	101.2	0.0
Rowena	101.4	101.4	101.8	101.8	101.6	100.8	101.4	101.8	0.4
Bettie	102.3	101.6	101.2	101.2	102.5	103.	102.	103.	0.7

It will be seen that all these animals were found to be free from tuberculosis. It is now intended to test the herd every six months.

It was the aim of the Station to make its former herd of moderate priced animals produce from 350 to 400 pounds of butter per cow by such methods as any dairyman might use. It is our intention to again seek the same end, and, at the same time, keep the herd healthy.

III. TUBERCULOSIS IN VERMONT.

Since the discovery of tuberculosis in the Experiment Station herd, the Station Veterinarian has had occasion to make in connection with work for the Cattle Commission and in private practice over a thousand injections of tuberculin. The cattle were from 90 herds, of which 83 were in Vermont and 7 were in the vicinity of New York city. Of 941 cattle injected, 222 were declared to be diseased by the tuberculin test, 220

*This cow had just calved and the following day was driven nine miles, hence her high temperatures. A later test has shown her to be free from tuberculosis.

were slaughtered and without exception were found tuberculous. Of 786 Vermont cattle injected, 138 were tuberculous; of 155 New York cattle, 84 were tuberculous. If we omit the Experiment Station herd and one other large herd where five-sixths of the animals were diseased, we find that of 662 cattle but 39 were tuberculous. These were in 81 different herds. These figures do not indicate the prevalence of the disease throughout the State, for, naturally, the injections were made in herds where there was reason to believe the disease existed. It is unsafe to predict the percentage of tuberculosis in Vermont herds from the data at hand, nor can it be determined except by systematic professional inspection. There is enough, however, to warrant the consideration of means for its control *We wish to distinctly call attention to the fact that no estimate of the percentage of tuberculous cattle in Vermont is made in this bulletin* lest some might construe the ratio of the tuberculous animals found by us in the inspected herds to which we have been called, to be that existing throughout the State.

The distribution of the disease in the various organs of 139 autopsies was found to be as follows: Lungs, 82 per cent.; bronchial glands, 61 per cent.; post-pharyngeal glands, 18 per cent.; mesenteric glands, 22 per cent.; lymphatic glands in general, 16 per cent,; portal glands, 6 per cent.; liver, 14 per cent.; intestines, 2 per cent.; udder, 22 per cent.; pleura, 7 per cent.; supermammary glands, 23 per cent.; peritoneum, 3 per cent.; spleen, prescapular gland and testicles each, 2 per cent.; uterus and ovaries each, 1 per cent.

Attention is called to the statement and bond of the State Cattle Commission on pages 66-68 of this bulletin.

IV. GENERAL DISCUSSION OF THE DISEASE.

Tuberculosis is the general name for a class of diseases, of which consumption in the human family is a common type. It is variously named* according to its location in the body and the character of its host. It attacks man, the domestic animals and sometimes wild beasts (particularly if in captivity). Among domesticated animals, cattle, fowl and swine more readily contract the disease than horses, sheep, dogs or cats. The latter easily succumb however, if inoculated either intentionally or accidentally. There is no animal known to be proof against the disease.

*Some of the more common names are: *Human; Lung;* consumption, pulmonary consumption, tuberculous consumption, phthisis, pulmonary phthisis, tubercular phthisis, pulmonary ulceration, quick or galloping consumption (acute miliary tuberculosis) old fashioned consumption (chronic tuberculosis;) *Bowels;* consumption of the bowels, many forms of chronic diarrhoea, cholera infantum and cholera morbus; *Nervous System and Brain;* tubercular meningitis, acute hydrocephalus; *Skin;* anatomical tubercle, lupus and scrofuloderma; *Bone and Joints;* hip-joint disease, white swelling of the knee; *Glands;* tubercular adenitis; *Abdominal cavity;* tubercular peritonitis, tubercular nephritis; *Animal;* same as in human, together with pining, wasting of the lungs, knots, kernels, grapes, angle berries, bovine tuberculosis, pearl disease, pearlsucht, also some forms of nymphomania, satyriasis, etc.

1. PREVALENCE AND HISTORY.

Human. The ravages of tuberculosis in the human family are far greater than are those of any other disease. The death rate from consumption, which is but one of its many forms, is about one in seven. In all its forms it is said to contribute to the death of one in every four, and the records of human postmortems indicate that one in two has had the disease and either died of it or had its progress arrested.

When conditions have favored its spread, the death rate from tuberculosis has been as high as 50 per cent. of all mortalities. Many of the fatal bowel troubles of infants have their origin in tubercular infection. An article in the Archives de Medicine says that "of the population of the globe, three millions die annually of consumption." It has been well said that, "if the 5490 deaths from tuberculosis which occur every year in the city of New York could be brought together in an epidemic lasting but one week, no small pox, cholera or yellow fever scare would approach the panic which would thus be created,....if we take the whole civilized world and compare with the tuberculosis mortality, all the accumulated deaths from war, famine, plague, cholera, yellow fever and small pox, the latter are comparatively very insignificant."[1]

Bovine. The lack of systematic professional inspection of live and slaughtered animals, as well as the actual variations in the extent of the disease in different localities give us somewhat contradictory data regarding the prevalence of bovine tuberculosis.

Probably many of the estimates given by various authors are based on faulty or insufficient data. The following examples may serve to some extent to indicate its prevalence. The extremes are wide, being from 0.02 per cent (among 2,273,547 cattle, mostly steers, killed in the meat inspection districts of the United States from May 15, 1891 to March 1, 1892)[2] to 60 to 70 per cent., (at Hildesheim, Hanover, according to Haarstick). In a large number of German abattoirs it is stated that 6.9 per cent. of the cows, 3.6 per cent. of the steers, 2.6 per cent. of the bulls and 1 per cent. of the young stock were tuberculous[3]. Of 1,270,604 animals slaughtered in German abattoirs from October 1888 to October 1889, 26,352 or 2 per cent. were tuberculous[4]. Careful postmortems by skilled veterinarians showed 12 per cent. of tuberculous animals out of 12,000 slaughtered in England as affected or exposed to contagious pleura pneumonia (a disease entirely distinct from tuberculosis)[5]. In seventeen counties in New York State the inspectors of the State Board of Health found 3.4 per cent. tuberculous

1 Law. Cornell University Experiment Station, Bul. No. 65. p. 105.

2. Salmon and Smith, Special Report on Diseases of Cattle etc., Bureau of Animal Industry, United States Dept. of Agriculture, 1892, p. 399.

3. Reported by Law. Ibid. p. 107.

4. Report of Imperial Health Office, Berlin. Vol. 7.

5. Annual Report for 1892 of Dr. G. T. Brown, Director of Veterinary Department of the Board of Agriculture of Great Britain.

cattle out of 20,000 inspected[6]. Cattle slaughtered at Baltimore were found tuberculous to the extent of from 2.5 to 3.5 per cent,[7] while of 1,153 cattle from the Eastern States (mainly New England) slaughtered at Brighton, Massachusetts, 52 or 4.5 per cent. were tuberculous[8]. Salmon and Smith state that "it is not far from the truth to assume....that one of every fifty head of cattle in the more densely populated areas of Europe and America is tuberculous"[9]. Dr. Salmon states yet later, however, that "the ideas in regard to the prevalence of tuberculosis have been radically changed by the facts brought out in using tuberculin[10]."

The fine showing of the Western abattoirs is mainly due to the fact that the beeves killed there are grown out of doors, are slaughtered while still young, and because as a rule only healthy animals are shipped to and accepted by them. On the other hand, Eastern and foreign abattoirs more often deal with stall-fed animals and with old cows, in both of which the proportion of disease is higher.

HISTORY.

Tuberculosis is no new disease. Both the human and bovine forms have been known for many centuries, under a great many different names. Four hundred years before Christ, Hippocrates[11] described the abscesses and ulcers of the lungs, which characterise the disease to-day. As early as the Middle Ages, the animal type of the disease was considered contagious and the flesh discarded. Various theories regarding its cause have been advocated and shown untenable. Until recently the theory of heredity was considered most probable, but it is now definitely proved that its true cause is bacterial.

2. ESSENTIAL OR EXCITING CAUSE.—THE BACILLUS TUBERCULOSIS.

Although infection by inhalation, (breathing), by inoculation (through wounds, etc.), and by feeding was definitely proved by Villemin[12] in 1865, and later by Cohnheim[13], Toussaint[14] and many others, the true cause of the infectiousness of tuberculous matter was not found until 1882. On March 24th of that year, Dr. Robert Koch of Berlin, Germany, read a paper before the Physiological Society of that city, in which he

6. County Gentleman, January 18, 1894.
7. Sixth and Seventh Reports Bureau of Animal Industry, p. 51.
8. Boston Board of Health. Report by Dr. Alex Burr, Inspector etc., for 1890.
9. Salmon and Smith, Ibid p. 399.
10. Breeders' Gazette, Chicago, June 14, 1893.
11. Littre's edit. of Hippocrates. V. p 675, VI. p 173, VII. p 73.
12. Etude sur la Tuberculose.
13. Ubertragbarkeit d. Tuberkulose, Berlin, 1877.
14. Compt. Rend. XCIII.

announced the discovery of the germ causing the disease[15]. He named this germ *Bacillus Tuberculosis.* The most painstaking care was used in verifying the facts before they were given to the world. Koch demonstrated the presence of the germ in the sputa (spittle) or tubercle (a round nodular mass of diseased matter, small or large, characteristic of tuberculosis), of over a hundred cases of consumption, and successfully inoculated nearly five hundred lower animals, producing in them the same disease. The concluding sentence of his paper has yet to be disproved: "We can with good reason say that the tubercle bacillus is not simply one cause of tuberculosis, but its sole cause, and that without tubercle bacilli you would have no tuberculosis."*

15. Berliner Klin. Wochenschrift, XV, 1882; also Mittheil aus dem Kaiserlichgesundheitsamte, "Aetiologie der Tuberkulose."

*It may not be out of place to define bacteria and to describe briefly the present status of the germ theory of disease. All matter, soil, air, water, and living beings, vegetable and animal, is prevaded with many forms of minute vegetable life. They belong to several more or less distinct classes or families, but, on account of their microscopic size, they are usually grouped under one name, micro-organisms. Bacteria, fungi, moulds, yeasts, etc., are types of this low order of plant life.

Bacteria (also called microbes and germs) are microscopic plants consisting of single cells or sacs, containing protoplasm, (the vital substance by which the process of nutrition, secretion and growth go forward) reproducing by division and by the production of single spores (a small grain analagous to seed in flowering plants.) Many are capable of motion. They are at present provisionally divided into groups (genera) based mainly upon their form. The principal groups are the globe-shaped bacteria (micrococus), the rod-shaped bacteria (bacillus) and the spiral or cork-screw-shaped bacteria (spirillum). Each of these has many hundreds of species. Each originates only in a germ of its own species, and is never spontaneously generated. Warmth, moisture and organic matter favor bacterial growth. Some species are readily destroyed, others, particularly in the spore form, are very resistant even to extreme degrees of heat or cold. Sunlight, air, (in time) the temperature of boiling water, and certain chemicals are generally destructive to germ life. Fungi, moulds and yeasts differ from bacteria mainly in their methods of reproduction. Many of the common operations of daily life, such as the raising of bread (in part), the souring of milk, the ripening of butter and cheese, the making of vinegar and the nitrifying of organic matter in the soil are due to bacterial action.

Disease also is often the result of the growth of bacteria in the bodily tissues. The pathogenic (disease producing) bacteria are mainly micrococci and bacilli. The causal relation of micro-organisms to disease is proved by the series of tests usually called "the four postulates of Koch:"

1. "The germs must be found in the blood lymph or diseased tissues of man or animal suffering from or dead of the disease.

2. The germs must be isolated from the blood lymph or tissue and cultivated in suitable media outside the animal body. These pure cultures must be carried on through successive generations of the organism.

3. A pure cultivation thus obtained must, when introduced into the body of a healthy animal, produce the disease in question.

4. In the inocculated animal the same germs must be found again."

This chain of evidence has shown that the causes of most contagious diseases are bacterial.

The germ theory of disease is that these minute plants grow in the body, that the products of their growth are poisonous, and that a definite disease is due to the effects of the poisons produced by a definite species of germ.

This germ (bacillus tuberculosis) is a parasitic, vegetable micro-organism, which under the microscope is seen to be a minute rod with rounded ends, usually slightly curved. It is about ten times as long as it is broad, aud measures on the average about one ten-thousandth of an inch in length. It occurs singly, in pairs, or in chains of from three to six. It probably does not reproduce itself by spores. This germ lives in the animal body and thrives best at a little above the normal temperature of the human body. It has great vitality, resisting heat, cold, moisture, drought, decay and often the process of digestion. Its virulence is not lessened by drying at temperatures below 150° F. A short exposure at 212° F. or a longer continued heating at from 160 to 170° F. is sufficient to kill the germ. These temperatures are not always attained in the interior of a piece of cooking meat, and a rare steak or roast, if from a tuberculous animal, may contain live germs capable of causing the disease in the person eating the meat. Milk may be used with safety, if heated for an hour at about 160° F. A higher temperature would be desirable, but it coagulates the albumen, gives the milk a boiled taste, lessens the digestibility and increases its tendency to constipate.

The tubercle bacillus has lived for many weeks in ice and been found virulent on thawing. Since moisture and decay do not affect it, wells, drinking troughs and burial grounds (human and animal), in short, wherever tuberculous matter has been exposed or placed, are all liable to be infected. The germ has been found in earth worms which had fed on tuberculous tissue, and it is evident that they may be factors in the spread of disease in bringing buried tuberculous matter to the surface.

SOURCES OF INFECTION.

There are three methods of infection:—

1 By inhalation (breathing the germs into the lungs).

2. By ingestion (swallowing the germs).

3. By inoculation (the entrance of the germ by some channel other than the lungs or stomach, as, for instance, through a cut or wound).

There are three general sources of infection:—

1. The dust of the dried sputa of consumptives or other tuberculous matter, either inhaled or swallowed.

2. Contact with the tuberculous material of those suffering from the disease, thus becoming infected either by inhalation, ingestion or inoculation. (For example, in kissing a tuberculous person there might be danger of either ingestion or of inoculation with the tuberculous sputa.)

3. The meat and milk of tuberculous animals. (The third source of infection is considered at length on pp. 55–61 of this bulletin.)

The sputa of consumptives containing tubercle bacilli is freely strewn around our streets and buildings Since the virulence of the germ is not

lessened by drying, dust is necessarily a common and omnipresent source of infection. The dust from our streets, stores, dwellings and places of assembly, particularly where tuberculous people live or congregate, is infectious. The dried sputa from the handkerchiefs, the beds and bedrooms of consumptives, and the mangers of tuberculous cattle are particularly rich with the germs. This is the main source of infection to human beings, one to which everyone is exposed. It is not too much to hope that this danger will grow less when more general destruction or disinfection of sputa is observed.

If this infectious principle is all about us, why does not every one die of tuberculosis? Many do thus die. As already noted the death rate from but one form of the disease is one in seven, and from all forms, nearly one in four.

Yet on the other hand we have powerful allies in pure air and sunlight. The harmless germs greatly out-number those that produce disease, the war between the various species is one of extermination, and myriads of the disease producing germs are thus destroyed. There are, moreover, natural forces in the body which are antagonistic to germ life. They are the real causes of immunity (the natural organized powers of bodily resistance to the attack of disease) against contagious diseases. There are three main theories explaining this matter. Metschnikoff[16] claims that the tissue-cells of the body, particularly the white blood corpuscles, attack and destroy micro-organisms and that in them the animal body possesses a formidable means of resistance and defense against these infectious agents. Buchner[17] and others consider that the blood serum and tissue juices have germicidal proprieties. On the other hand, Lister[18] claims for the bodily tissues a certain standard of vitality by which they are able to ward off the attack of disease-producing germs. While this standard is maintained the attack is in vain, but when the infection and reduced vitality occur together there is chance for disease. The germicidal action of healthy gastric juice is universally admitted. Immunity against recurring attacks of the same contagious disease is explained in two ways, one by the exhaustion of the peculiar food of the specific germ in the first attack, the other by the existence in the body of sufficient quantities of the self-made germ poison to kill all new comers of the same species.

3. ACCESSORY OR PREDISPOSING CAUSES. CONDITIONS FAVORING THE DEVELOPMENT OF TUBERCULOSIS.

There are certain conditions of birth and modes of life which are potent factors in the spread of tuberculosis. The tubercle bacillus alone is

16. Lecture to Institut Pasteur, Dec. 29, 1890.

17. Eine neue theorie über Erzielung. Immunität gegen Infectionskrankheiten, Munich, 1883.

18. Quart. Jour. Micr. Soc. Lodon, 1881, n .ns. XXI p. 330-342.

its true exciting cause, but there are conditions so favorable to its development that they are well-termed "accessory causes," although strictly speaking they are not causal. The kernel of corn is the essential cause of the growth of the corn plant, and soil, moisture and warmth are accessory causes furnishing conditions favoring its development. The kernel could only grow with great difficulty, if at all, without their help; but on the other hand, there could be no growth whatever, no matter how rich the soil or how favorable the season, unless the seed were planted. Similarly in disease the malady develops only when the germ is present, but the circumstances of individual cases, bodily conditions and surroundings, etc., are of the greatest importance in determining the result.

Among the conditions favoring the development of tuberculosis, if the tubercle bacillus is present, are:—

A. Hereditary predisposition.

B. Unhealthy surroundings; poor ventilation; uncleanly, dark, damp, hot and cold stabling; soiling system; lack of exercise; climatic influences.

C. Faulty feeding; under feeding; over feeding; feeding on unwholesome or indigestible materials; overproduction.

D. Faulty breeding; in and inbreeding; early, late and frequent breeding; intensive breeding; lack of constitution.

E Ill health. Temporary predisposition.

F. Physical conformation.

A. HEREDITARY PREDISPOSITION.

For many years consumption was considered a hereditary disease, transmitted from parent to offspring. It was said to run in families. It is now known to be but rarely hereditary, the proved cases of the infection of the fœtus in the womb being less than a dozen. There are on record but six cases of indubitable congenital tuberculosis in calves.[19]

It is not strange that this belief should have prevailed before the discovery of the germ. The well-known prevalence of tuberculosis in certain families is mainly due to two causes; first, to the concentration of the germs in the family home, and, second, to a *lack of resistance, an inherited predisposition to this disease.* A person not thus susceptible may live uninfected in a family whose every member contracts the disease. All breathe the germ laden air, but the unfortunate family are a fruitful soil for its growth, while the stranger is not. Such facts are of common occurrence, and are best explained upon the ground of hereditary predisposition. This inherited tendency is found in cattle as well as in human beings. Dr. Law says: "In 1877 I recognized the existence of tuberculosis in the Jersey

19. Jour. Comp. Med. and Vet. Arch., Oct., 1893, p. 240.

herd of Burton Bros., of Troy, N. Y. The worst were slaughtered, but some incipient cases in young animals were turned out in a pasture by themselves, where they passed the summer in apparently robust health, but they began to droop when they returned to the barn in the fall. I again visited the herd and picked out eleven diseased animals and had them killed, when Dr. James Burton informed me that I had destroyed every representative of a certain family, not even a grade having been left. From that time on there was no more trouble with tuberculosis in that Jersey herd[20].'

B. UNHEALTHY SURROUNDINGS.

Imperfect ventilation has much to do with spreading infection. This is because of the repeated breathing of the same air, full of dust and germs, and because of the concentration of the bacteria within a small place. The lack of oxygen lowers the vital powers of animal or man and renders them less able to cope with the germs. An open air life prolongs the life of the consumptive. Tuberculous cattle which are unthrifty in the barn are often apt to pick up on pasture, and to run down again on returning to the barn in the fall (as in the case of the Burton herd cited above.) Of 2,273,547 fat cattle inspected by the officers of the Bureau of Animal Industry at Western abattoirs, only 492 (.02 per cent.) were tuberculous, while out of 54,158 cows from city and country barns 669 (1.23 per cent.) were tuberculous[21]. There were fifty-seven tuberculous animals raised in confinement to one whose life had been spent out of doors. Other data, American and European, might be cited showing the relatively high percentage of tuberculosis in stabled cows.

Dark, damp and hot or cold stables are often partly responsible for the spread of tuberculosis. Light is a germicide, darkness a germ-preserver. Light favors the formation of the red corpuscles of the blood. When their numbers decrease, the offices of the blood, including its germicidal action, are impaired and the bodily vigor lessened. The effect is the same as if too little oxygen were inhaled, i. e., equivalent to the effects of poor ventilation. Dampness favors colds, which, as is well known, are often the beginning of consumption. They make the soil more fertile for the growth of the seed. Hot stables make the animal tender and liable to catch cold. Cold stables, or turning cattle out in bitter weather are apt to bring on colds, bronchitis and pneumonia, which prepare the way for tuberculosis of the lungs.

Soiling cattle, their confinement with little or no exercise the year round makes unending the conditions already cited which otherwise last

20. Law, Tuberculosis in Animals. Report New Hampshire State Board of Agriculture, 1892. page 16. Also reported in Cornell Univ. Expt. Stat. Bul. 65, p. 112.

21. Salmon and Smith, Ibid, p. 399.

but half the year. Local circumstances sometimes compel this method of dairying, but cattle thus kept should be watched with great care for indications of disease.

Climate has its influence in spreading tuberculosis. A moist, changeable climate favors its development, while dry and rare air and uniform temperature tend to suppress it. The high table lands of the far western states afford relief to the human consumptive and possibly to the animal. Bovine tuberculosis is said to be unknown in those regions, and there are those who believe that in its earlier stages its course may be arrested by removal to high altitudes.

C. FAULTY FEEDING.

It is self-evident that underfeeding and the use of unwholesome or indigestible food lowers the vitality and hence the resistant powers of the animal. Overfeeding, either as gluttony or in the use of too rich a ration, or irregular feeding, are apt to cause indigestion and dyspepsia, thus predisposing to the disease. Heavy, stimulating feeds lead to over-production. The high production of milk and butter places the animal under a severe strain and tends to weaken her constitutional vigor and increases susceptibility.

D. FAULTY BREEDING.

*In and in-breeding** intensifies both good and bad traits. It concentrates desirable lines of personal and family character, but, unless carefully and intelligently managed, is liable to weaken constitution and conduce to disease. Line breeding, the most desirable type of in and inbreeding, is that by which our improved breeds of domestic animals were originated and perfected, and, when due regard is given to ancestral health and vigor, is often advantageous. Incestuous breeding, however, is to be condemned for it increases susceptibility, and often produces unsatisfactory results. Cattle thus inbred are proverbially liable to tuberculosis.

Early, late and frequent breeding are all liable to sap the bodily strength. The nourishment which should restore the maternal vigor is diverted to

*In and in-breeding is usually considered to mean the pairing of close relations. Breeders differ as to degree of relationship covered by the term. It may mean only the coupling of animals of the precise same blood (brother and sister) or the frequent pairing of relations. Miles calls attention to the confusion of definitions, and says: "If the terms in-breeding, close breeding and interbreeding are used to indicate the breeding together of closely related animals in a single instance, or at long repeated intervals, the term in and inbreeding could then be used with greater exactness to indicate the frequent repetition of the process." (Stock Breeding p. 138). For the present purpose the distinction may be drawn between incestuous breeding (brother and sister, parent and offspring, etc.) and line breeding (within the limit of a family and for a particular type of animal, generally without regard to relationship, not of necessity incestuously bred, but closely bred.)

the development of the unborn offspring and to the making of milk. If bred too young, the mother's growth is stunted, and the offspring is apt to be weak and puny; if bred too late or too often, the constitution suffers from the strain. All such are probably more susceptible to infection than if bred with more care.

Intensive breeding, the mateing of animals of great milking strains with the hope of yet greater performance in the offspring, is attended with the dangers already cited due to the artificial nature of the animal, and needs to be done with intelligence. Breeding from animals themselves tuberculous is, of course, to be condemned. This itself is not apt to produce the disease, but the offspring have decided predisposition.

Tuberculosis is not confined to any breed, nor is any breed exempt from it.

The modern dairy cow is a highly artificial animal. She has been compared to a machine for the conversion of raw material, fodder, into the finished product, milk. The intelligent engineer works his machine to the full extent of safe production. The dairy cow should be similarly handled, and an undiminished strength of constitution made the measure of her production. The better types of the modern dairy cow are striking examples of ability, energy and intelligence in lines of breeding and feeding. These are by no means to be abandoned. *We argue for a due regard for the danger which attends high production, for healthy surroundings and vigorous ancestry, and for a watchful, intelligent care to weed out and keep out disease.* The valuable qualities of our best dairy cows may thus be preserved and transmitted, uncontaminated, to future generations.

E. ILL-HEALTH.

Sickness of any kind, acute or chronic, favors infection. This is particularly true of such as irritates the organs of respiration (colds, bronchitis, pneumonia, etc.) or interferes with digestion (dyspepsia, indigestion, diarrhœa, etc.) An enfeebled system less vigorously resists attack. An irritated respiratory tract is fertile surface for the growth of the tubercle germ. The healthy gastric juice, being acid, kills most germs, but an unhealthy stomach with weakened or diminished secretions offers less resistance to the passage of bacteria to the alkaline bowel where all the conditions are favorable to their growth and multiplication.

Temporary predispositions to tuberculosis occur in all individuals, human or animal. A hard cold, an overworked condition, or a fit of indigestion renders one temporarily much more open to infection than usual. Our bodies are continually at warfare with the germs. In health we conquer, but if the vitality be lowered we become for the time being susceptible. Since we cannot predict when infection and lowered vitality will coincide in ourselves or our animals, it is desirable to avoid both so far as possible.

F. PHYSICAL CONFORMATION.

Cattle with narrow chests, light barrels and long legs are, because of their build, apt to be predisposed to tuberculosis. Their circulation is generally poor, and they are apt to be poor feeders and unthrifty.

4. SYMPTOMS OF BOVINE TUBERCULOSIS.

Tuberculosis in cattle sometimes assumes the acute form, but is usually of the chronic type, lasting for years. Mankind attacked by either form generally shows it by failing health. Cattle, on the contrary, seldom give external evidence that they have the disease until it is far advanced. The effects of the disease are too slight at first to materially interfere with the functions of the organs involved. The animals may and do live for years with decided tubercular lesions, and yet appear healthy, fattening readily and yielding large amounts of apparently normal milk. In the acute form, however, and in the last stage of the chronic, fever and wasting of the body occurs. The marked difference in outward evidences of human and bovine tuberculosis lead many to doubt its existence in apparently healthy animals. The public slaughter of tuberculous cattle is always accompanied by a storm of protests from bystanders, which are generally quieted by the post-mortem results.

Although difficult to detect in its early stages, except by the use of tuberculin, the symptoms of tuberculosis are quite marked when the disease is well advanced. The following concise description of advanced bovine tuberculosis is taken from the Special Report of the Bureau of Animal Industry on "Diseases of Cattle and Cattle Feeding," page 405. Lydtin quotes the following description of the disease as taken from a Swiss sanitary order:

"A dry, short, interrupted, hoarse cough, which the sick animals manifest especially in the morning at feeding time, still more after somewhat violent exertion. At first these animals may be full-blooded and lay on a considerable amount of fat when well fed. As the disease progresses they grow thin and show more and more those appearances which indicate diseased nutrition, such as staring, lustreless, disheveled coat; dirty, tense skin, which appears very pale in those regions free from hair. The temperature of the skin is below normal. The loss of fat causes sinking of the eyes in their sockets. They appear swimming in water and their expression is weak. The cough is more frequent, but never or very rarely accompanied with discharge. The body continues to emaciate even with plenty of food and a good appetite, so that the quantity of milk is small. At times in the early stages of the disease, still more in the later stages, the diseased animals manifest considerable tenderness when pressure is applied to the front or sides of the chest, by coughing, moaning, etc. Often all symptoms are wanting in spite of the existence of the disease."*

*After mature consideration and consultation with the Board of Control of the Station and the State Board of Agriculture (acting as Cattle Commission) it was deemed inadvisable to attempt to describe the symptoms of bovine tuberculosis more fully than above, on the ground that they were so obscure and variable except in advanced cases that any description would be apt to be more misleading than instructive.

5. LESIONS OF BOVINE TUBERCULOSIS.

It is not a simple matter for the non-professional to detect bovine tuberculosis, and in many cases the trained veterinarian cannot determine its presence by physical examination. More definite knowledge may be obtained by the following means:

1. Examination of the sputa and milk with the microscope for the tubercle bacillus.
2. Inoculation of smaller susceptible animals (rabbits, guinea-pigs, etc.) with the suspected material.
3. Slaughter and post-mortem.
4. The injection of tuberculin.

Dismissing the first two means as not within the scope of this bulletin, the third may be used either alone or as confirmation of the fourth. In either case it is desirable to be able to recognize the lesions (changes produced in the texture of the organs by the action of disease) of tuberculosis.

The organs usually affected are:—

1. Breathing: The lungs, throat and their glands.
2. Digestion: The stomach, intestines, mesenteric glands.
3. Abdominal glands and urinary organs: The liver, spleen, pancreas, kidneys and bladder.
4. Reproduction: The womb, ovaries and fallopian tubes.
5. Lactation: The udder and its lymphatic glands.
6. The lymphatic glands in general.
7. Serous membranes; pleura, peritoneum, pericardium.
8. The skeleton; bones, joints.

Sometimes but one organ is affected, sometimes several, the symptoms varying with the location of the disease. In the former case the disease is called localized, in the latter, generalized tuberculosis.

The lungs and bronchial glands are most commonly affected, then the intestinal canal. The distribution of the disease in the various organs is well shown in the following tables of post-mortem examinations copied in a condensed form from the "Report on Tuberculosis in Ontario, presented to and adopted by the Provincial Board of Health, by P. A. Bryce, M. A., M. D. Secretary." The results obtained in cattle by one of us is added at the foot of the table.

Class of *post mortem*.	By whom.	Number in each.	Lungs.	Bronchial and Mediastinal Glands.	Pleura.	Mesentery and Intestines.		Liver and Uterus.		Spleen and Udder.	
						Mesentery.	Intestines.	Liver.	Uterus.	Spleen.	Udder.
			%	%	%	%	%	%	%	%	%
Ontario Agricultural College herd	Mackenzie	28	64	85	..	7	7	42	..	..	7
Ottawa Experiment Farm herd	Robertson	30	83	73	26	13	4	43	6	..	..
New Jersey (cattle)	Conrow	48	70	56	..	....	.	..	..	2	25
Germany (cattle)	Roeckl	7329	75	29	55	48	1	28	10	19	..
Vermont	Rich	138	82	61	7	22	2	14	1	2	22

In 7, 329 cases of more exact returns of *post mortems* in cattle, the results are given as follows :

		Per cent.
General tuberculosis	459	6.26
Lungs	5,178	75.37
Pleura pulmonalis	3,812	55.49
Peritoneum and mesentery	3,316	48.27
Pleura of chest-wall	3,209	46.71
Bronchial glands and mediastinal glands	2,022	29.43
Liver	1,940	28.24
Spleen	1,273	18.53
Uterus	699	10.17
Inguinal glands	364	5.30
Pharyngeal glands	299	4.35
Trachea	233	3.39
Udder	111	1.62
Intestinal	89	1.30
Ovary	86	1.25
Lymph glands of liver	80	1.16

The lymphatic glands of the thorax and abdomen, the heart, kidneys, stomach, brain, bones, etc., were found diseased in less than one per cent. of the cases.

Wherever the germs locate in the body, they multiply, thus irritating the tissue, forming a round nodular mass, the so-called tubercle, which

gives the disease its name. The newly formed tubercle is always small usually about the size of a millet seed,* is soft and red, or sometimes firm, white and fibrous. In chronic cases, aggregations of small tubercles become soft and cheesy with a limy material in the centre, disintegrate and run together, forming yellowish, cheesy masses of various sizes imbeded in the tissue of the organs involved. These masses of degenerated or broken down tissue contain caseous (cheesy) matter, calcareous (limy, gritty) matter and pus, sometimes one, and often two or all of these. This degeneration is caused by the actual death of the tissue. Unless the lesion is recent the mass is sometimes enclosed in several concentric layers of connective tissue like the skin of an onion, an effort on the part of nature to bury the diseased portion and render it harmless.

The surface of the lungs, pleura, (lining of the chest cavity over the ribs and diaphragm) and peritoneum (lining of the abdominal cavity) are frequently studded with tubercles, being sometimes so thick as to resemble a cobblestone pavement, or, with clusters of tubercles which look like miniature bunches of grapes. This form of the disease is commonly called pearl disease, pearlsucht, grapes, angleberries, etc. Several of the Station herd were thus affected. The lymphatic glands are usually enlarged, caseated and calcareous. They are often almost impossible to cut open, because of the deposit of gritty material. The bronchial lymphatic glands which normally are about as large as horse-chestnuts are particularly liable to enlargement and degeneration. The bowels may be ulcerated and have tubercles on them. In short, any organ affected will have tubercles in it varying from the microscopically small miliary tubercle through the pea-sized, soft red or firm white nodule, to larger masses of degenerated tissue, caseated, calcareous or broken down into pus. (See plates showing lesions, pages 48-49.) Sometimes the tubercles are all so small that it requires microscope to detect their presence. The cow Creamer, belonging to the Station herd, was thus affected in the udder, there being almost no evidence of the disease elsewhere. She would have passed any abattoir inspection as sound and healthy, yet her udder was full of microscopic tubercles and her milk unquestionably infected.

These lesions are characteristic of the disease and their extent measures its progress. Glanders (which does not affect cattle), actinomycosis (lump-jaw) and pleurisy with adhesions are the only diseases which are liable to be confounded with tuberculosis. Usually the restricted localization of the lesions of the two former will serve to distinguish between them. In lump-jaw the lung often contains cheesy masses, rather more yellow than are those due to tuberculosis and containing small grains. In pleurisy with adhesions, in which the lungs have to be

*The comparison in size to a millet seed has given a name, acute miliary tuberculosis, to that orm of the disease in which the tubercles are all small and form rapidly.

torn away from the ribs, the absence of tubercles will aid in determining the character of the disease. Both glanders and actinomycosis are contageous to both man and beast. No mistake would be made in slaughtering the animal whichever disease was at fault.

The one entirely satisfactory evidence of tuberculosis is the detection of the germ and reproduction of the disease. If a germ is found in a nodule of any character which is a rod about one ten-thousandth of an inch long, which both stains and bleaches with difficulty, it is probably tuberculosis. If the tissues injected into a susceptible animal produce tuberculosis, the diagnosis is established beyond question.

6. THE TUBERCULIN TEST.

In August and November, 1890, Dr. Robert Koch[22], the first to identify the tubercle bacillus, published the results of experimental work upon tuberculous guinea pigs with a fluid of his own preparation. This fluid (Koch's lymph or tuberculin) was stated at a later date to be the concentrated, sterilized and filtered liquids in which pure cultures‡ of the bacillus tuberculosis had been grown[23].

It has been know for many years that animal decomposition and putrefaction are the results of bacterial growth. The growth of many of these germs gives rise to the formation of peculiar alkaloids,* most of which are very poisonous. These bodies as a class are called corpse alkaloids or ptomaines, from πτομα a dead body. The many cases of poisoning from eating cheese, ice cream, fish and putrid meat are usually due to the formation of ptomaines in these materials. It is now believed that each disease producing germ develops, as a function of its life, ptomaines peculiar to itself†. Many of these have been isolated and their properties determined. Tuberculin being a glycerine extract of pure cultures of the tubercle bacillus contains the ptomaines peculiar to that germ, the chemical poisons which the life functions of the germ have created. These are the immediate though not the ultimate causes of tubercular lesions.

Tuberculin is prepared by growing the tubercle bacillus in a pure culture until highly concentrated and until a large amount of its ptomaines is developed. Glycerine and carbolic acid are then added and the mix-

22-23. Deutsche Med. Wochenschrift, 1890.

‡ A pure culture consists of the growth of one species of germ by itself, all others being excluded.

* Organic chemical compounds, existing in many vegetables and animals, containing nitrogen, carbon, hydrogen and oxygen. They generally include the active principle of the plants. Examples: Theine in tea, morphine in opium, quinine in Peruvian bark, strychnine in nux vomica, tyrotoxicon in poisonous cheese, ice cream, etc.

† See last paragraph of the footnote on page 34 for "germ theory of disease."

ture is filtered through a porcelain plate to remove the germs. The filtered fluid is heated to a high temperature to destroy the vitality of any germs which may have passed the filter and then evaporated at a low temperature in a vacuum until concentrated. The German or Koch tuberculin is put up in five gram bottles and retails in New York for about $10 a bottle ($1,000 a pint). It is diluted one to ten, before use. The tuberculin made by the Bureau of Animal Industry is put up in in 12 c. c. bottles and is used without dilution

The test with cattle is made by injecting the fluid under the skin of the neck or shoulders by means of a sterilized hypodermic syringe. The syringe and the skin and hair at the point of injection are first carefully disinfected in order that no disease-producing germ may enter the system. The German tuberculin is diluted with nine times its volume of a one per cent. solution of carbolic acid, and from one to four cubic centimeters (a cubic centimeter is about one-thirtieth of a fluid ounce) of the diluted lymph is used. The cost of the tuberculin used in an average sized injection is about fifty cents.

The normal temperatures are usually taken before and at injection. Tuberculous animals respond by a rise in temperature, usually beginning from six to ten hours after injection, but exceptionally not showing until as late as sixteen to eighteen hours. There is usually no marked swelling at the point of injection, but sometimes uneasiness, rigors, chills and diarrhœa are noticeable. Diarrhœa often affects healthy cattle also, and is caused by the expulsion of the tuberculin by way of the bowels. In some of our work at this Station and in the State the "normals" * have been taken some days after injection. This has worked well and saved taking the "normals" of animals which lat r prove to be healthy. It is not safe, however, to take these temperatures the day after injection, as the temperature often rises the second day nearly as high as on the day after injection. All temperatures are taken by inserting a clinical thermometer into the rectum or vagina for from three to five minutes. Normal temperatures should be taken at least twice. The temperatures after injection should be taken at least once in three hours, beginning six hours after and continuing until twenty to twenty-four hours after injection. Variations occur in the normal temperatures of different cows and of the same cows at different times in the day. The average normal temperature of a cow is not far from 101.3°F. It may rise to 102.5° or sink to 100°. *An increase of 2° over normal temperature after injection is ground for suspicion*, unless there is evident reason for it (cow in heat or near calving, change of conditions or surroundings, etc.) while higher figures make the case yet more clear.

There is need of careful observation and trained intelligence in the interpretation of the results of the tuberculin test, since apparent reactions

* The temperatures taken before injection.

sometimes occur which might mislead the unskillful or careless. *The test is too delicate for ordinary hands.* The Bureau of Animal Industry and the importers of the German goods are exceedingly conservative in placing the lymph only with responsible parties.

The action of tuberculin upon the tubercle bacillus is that of an excitant. It arouses the germs to increased activity, hastens the progress of the disease, tends to scatter the infection throughout the body and throws the animal into a feverish condition, as shown by a rise of bodily temperature of from 2° to 8° F. The tubercular tissue degenerates rapidly through the usual stages, the germs rapidly increase in number, a new extension of the disease in the form of acute miliary tuberculosis usually occurs and death by so-called "quick consumption" ensues. This action is what brought Koch's lymph into disfavor as a cure, except in cases of lupus (tuberculosis of the skin) and other localized forms of the disease where the diseased tissue is sloughed off. But the very features which prohibit its use as a cure are those which give it its value as as a diagnostic agent (means of determining a disease by distinctive marks, symptoms or characteristics) in cattle. The tuberculous animal because of the very presence and action of the tubercle bacilli in its system becomes more or less charged with tuberculin. The system is inured to this, however, but it is supposed that its balance is upset by the injection of more tuberculin, the germs are excited to greater activity and fever ensues.

Tuberculin was first used as a diagnostic agent in veterinary practice in 1891 by Prof. W. Gutmann[24], of the Veterinary Institute, Dorpat, Russia. The Tuberculosis Commission of the Veterinary Department of the University of Pennsylvania, Prof. W. L. Zuill[25], Chairman, were the first to use it in this country, late in the same year. Many of the Experiment Stations, Cattle Commissions and veterinary surgeons of this and other countries have experimented with it since this time and have generally found it successful.

The Experiment Stations of Canada, Vermont, New York, New Jersey, Pennsylvania, Virginia, Wisconsin and Minnesota have used it with convincing results. A list of their publications on the subject will be found at the end of this bulletin.

Quotations might be made from the reports of many investigators, American and foreign, but the following may suffice:

"We shall now stop publishing reports on tuberculin in the Berlin Veterinary Weekly unless they contain some new facts or views. Since the publication of the reports of the extensive experiments of the Royal Health office, we may regard the question of the value of tuberculin in the diagnosis of tuberculosis of cattle as settled. The proof which has been pre-

24. Balt. Woch. f. Landw. Geweberfl. u. Handel; also reported in Deutsche Molkerei Zeit., 1891, pp. 81-83.

25. Jour. Comp. Med. and Vet. Arch. Nov., 1891.

sented to our readers is more than sufficient. The results are absolute and gratifying, and show that tuberculin is a reliable agent for determining the presence of tuberculosis in cattle[26]."

OBJECTIONS TO THE TUBERCULIN TEST.

Objections having some basis in fact have been raised to the use of tuberculin in veterinary practice. They are, briefly stated:

1. The temperature of healthy animals and those affected with other diseases sometimes rises after the injection of tuberculin.

2. Some tuberculous animals do not react to tuberculin.

3. Tuberculin does not determine the stage of the disease, but condemns animals which might live for years and possibly recover.

4. Tuberculin may produce the disease in healthy animals, and certainly hastens its progress in those affected.

5. Any test to be effective must be followed by thorough eradication. It is impossible to stamp out tuberculosis for financial reasons and because of its prevalence in the human family.

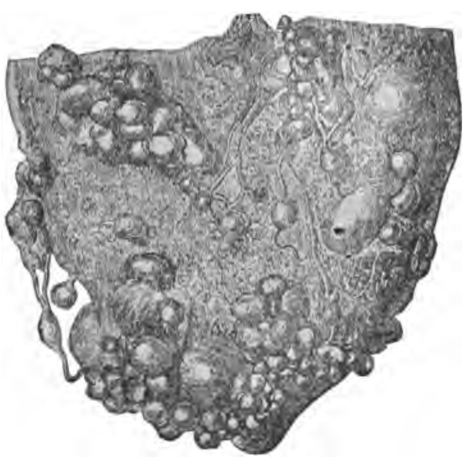
To the first, second, third, last half of the fourth and the fifth counts in the inditement the test must plead guilty. *The tuberculin test is not infallible.* There have been mistakes made in its use by incompetent persons and it has occasionally failed in careful hands. Experience, however, has brought a greater measure of success, unfavorable reports are now rare and many who considered tuberculin unreliable are acknowledging that the fault was their own. But, notwithstanding its occasional and admitted failures, it has proved infinitely more reliable than any other means of diagnosis now in use.

Let us consider these objections:

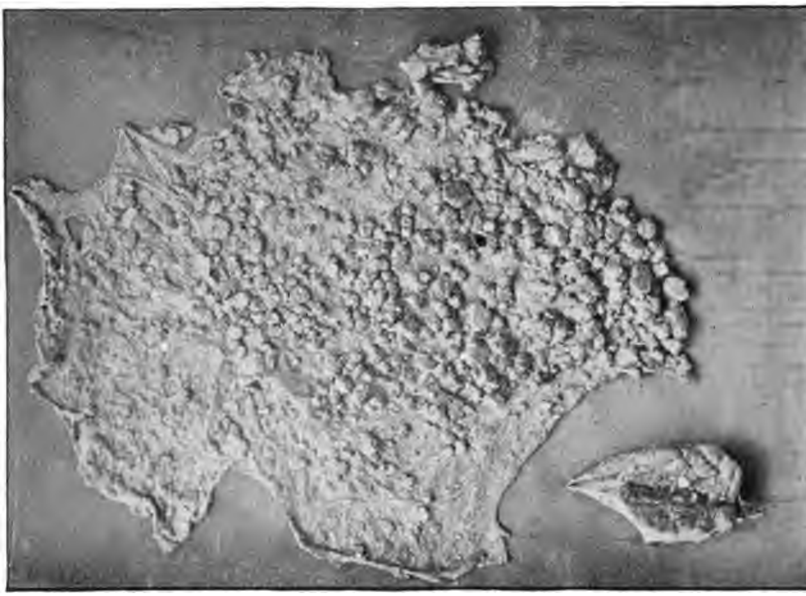
1. Apparent reaction of non-tuberculous animals.—Every animal is liable to fever and may be thus affected after a tuberculin injection independant of tubercular lesions. A cow for a few days before, at, and for some days after calving may have abnormally high temperature. Yet, on the other hand, one of us has had healthy cows calve in the middle of the test without showing any fever whatever. We have also found that the standing, due to the necessity of frequent taking of temperature, tends to cause acute laminitis (inflammation of the sensitive structure of the feet) accompanied by a rise of temperature, which might be mistaken for a reaction caused by tuberculin. The altered conditions of confinement during summer when the cows are naturally at pasture may also cause a fevered condition. Cows in heat are apt to be feverish. The temperatures of such cows fluctuate more than those of a cow reacting to tuberculin. Such cases are usually readily detected by the careful observer. Great care should be used in the inter-

26. Berliner Thier. Wochenschrift, June 16, 1892.

Section of a lung tubercle from Experiment Station cow "Sadie's Delight." The tubercle is the bean-shaped mass standing out from the cut. It contained caseous and calcareous matter.



A portion of a tuberculous lung (bovine.) [After Virchow.]



An aggravated case of tuberculosis of the omentum (covering of the abdominal viscera); also a tuberculous gland. (Reproduced from photograph loaned by Dr. Drinkwater, Rochester, N. Y.)

Opened glands from Experiment Station cow "Floss." The caseous degeneration is shown by the roughened surfaces. These glands are several times normal size.

pretation of the results of the injection of two-year-olds with their first calf. The explanation for this may be that the changes caused by their first gestation are such as to render their systems readily fevered by any excitement. Care should be taken not to inject directly into a lymph or blood vessel, lest neighboring glands become inflamed. Mistakes have been made by careless post-mortems, and many who have reported reactions in healthy animals are acknowledging that they failed to make careful examinations of all organs, bones, joints etc., or did not use the microscope. It has been claimed that animals suffering from actinomycosis may react to tuberculin. From a practical standpoint, since lump jaw is contagious, and communicated to man, this makes little difference, yet it is not impossible that there may have been tubercular lesions overlooked in these cases. One of us had two cases of this kind. One cow with lump-jaw gave no reaction whatever to tuberculin; another with both tuberculosis and lump-jaw gave the highest reaction (108.6°) yet obtained.

2. *Non-reaction in tuberculous animals.*—These cases are sometimes found. We have found two cases of non-reacting tuberculous cattle in over a thousand injected. This may be explained in two ways. It is a well-known fact that some individuals are not affected in the ordinary manner by certain drugs. For instance, morphine does not narcotize some people. It is possible that these cases may be similarly explained. Or, the animal may be so thoroughly diseased that its system is already saturated with the natural tuberculin, so that the slight addition has no effect. Usually such cases may be detected without recourse to tuberculin or in spite of its lack of reaction. We have noticed in our experience that very old cows do not respond so readily to the usual amount injected.

3. *Indiscriminate Condemnation of all Stages of the Disease.*—Neither the length of time elapsing between injection and reaction, the duration, or the heighth of the fever indicate the extent of the lesions of the disease. The slightest and most recent cases, as well as those of long standing are betrayed. Herein lies the peculiar value of the test. It is questioned by some veterinarians whether for practical purposes animals very slightly affected should be considered tuberculous. Probably many might live for years without marked advance of the disease. But who shall say in such cases when the danger line is passed? Is it worth while to prolong for a year or two the life of a few confessedly tuberculous animals to run the risk of infecting a herd as well as human beings? While many animals but slightly affected might live for years in apparent health and usefulness, a tuberculous animal, whatever its condition, is a constant menace to the other members of the herd, and to those who care for it or consume its products. If to-day the germs are inactive, to-morrow they may pass into the blood, to the udder and infect the milk. It is stated on good authority that the tubercle germs may exist in the milk even when the udder is not affected. The preservation of a single tuber-

culous animal invites renewed disease. There are as yet few, if any, authenticated published accounts of cured bovine tuberculosis, although possibly favorable climatic conditions may arrest the progress of the disease. Viewed solely from a monetary stand-point the truer economy lies in the exclusion of every possible source of future infection.

4. *Production of the Disease in Healthy Animals and its Aggravation in Tuberculous Animals.*—Tuberculosis is primarily due to the tubercle bacillus. If the lymph is properly made and sterilized every germ and spore in it is killed, and hence it cannot cause the disease.

During the preparation of this bulletin one of us wrote to a large number of veterinarians all over the United States, asking among other questions whether it was possible for tuberculin to cause tuberculosis, or any other disease, in a hitherto healthy cow. But two replies were received in the affirmative while a large number claimed the impossibility of such infection with properly made and carefully handled tuberculin. These two replies were received from gentlemen, eminent in the profession, who have been working together. They base their belief in the possible infection of healthy animals upon the fact that they have found the bacillus in tuberculin, and they claim that it is unwise to use the material until more is known of its power to produce immunity, or possibly a predisposition to tuberculosis.

The first claim simply emphasizes the necessity of care in the preparation and use of the material. The lymph was first used for diagnostic purposes in veterinary practice nearly three years ago, and the evidence is already strong against the probability of any predisposition being caused. For example, the Pennsylvania Experiment Station herd was first injected in June, 1892 and has been twice injected since, the last time within a few weeks. The disease was discovered on the first injection, but not on either of the succeeding trials[27]. It is nearly two years since we first used tuberculin and cattle then injected and recently retested have shown no evidence of disease. While this evidence is only negative, it is confirmed by similar tests elsewhere. There is still much to be learned in the use of tuberculin. It is already claimed that other materials will cause the same febrile reaction. Taurin and Kreatin (Merck's) have given good results in the hands of Dr. W. L. Zuill of Philadelphia, and E. Centauni claims that "it has been proved that identically the same action as that of tuberculin can be produced by the injection of the extracts or other products of various bacteria, even such as are known to have no pathogenic (disease-producing) proprieties[28]." If further experiment confirms these results, and these or other materials are found to be as reliable as tuberculin, they should and undoubtedly will supplant it, since they obviate the danger which lies in careless making and use of tuberculin.

27. Penn. State Coll. Agl. Expt. Stat. Bul. No. 21, Oct. 1892.
28. Berliner Klinische Wochenschrift, Nos. 7 and 8, 1894.

The aggravation of the disease in tuberculous animals is not a valid argument in cases where such as react are promptly killed. No one who expects to keep his mild cases should permit its use, for it only makes a bad matter worse.

5. *A thorough eradication an impossibility.*—The complete eradication of tuberculosis, its "stamping out" is not a work of years, but of decades, perhaps centuries. But increased knowledge and better means of detection enable us to make a stronger fight against it. We now know how and why it attacks, may detect its presence and do much to prevent its ravages. We may confidently expect yet more light as time goes on. If we cannot eradicate tuberculosis in the near future, let us do what we can in that direction.

When the great conflagations of Chicago and Boston were at their height, the firemen did not reel up their hose and go home because the flames were apparently beyond their control. They worked around the edges of the fire, and blew up buildings yet unburned in its path. They did what they could, and finally controlled the flames. Similarly, in the battle with human and animal tuberculosis, weeding out disease here and there, disinfecting, and the destruction of property in the shape of animals in the interests of the public health are good policy until better knowledge and means enable us to do more complete work. The question of the relation of the State to the individual and to disease will be considered later in the bulletin, (pages 63-68.)

7. INTER-RELATION OF HUMAN AND BOVINE TUBERCULOSIS.

Bovine tuberculosis is infectious. Hundreds of experiments have proved that this disease may pass from a tuberculous to a healthy animal. Stahl cites 650 experiments in the transmission of tuberculosis to lower animals by direct experiment with convincing results in every case. Koch[29] and others have inoculated healthy animals of many sorts with tuberculous bovine tissue and reproduced the disease. Bollinger[30], Ernst and Peters[31] and others have infected calves and swine by feeding them tuberculous milk. The unboiled milk of tuberculous cows, without indications of diseased udders, infected a herd of English pigs[32]. The mother of calf No. 3 of the Station herd is healthy, and the tubercular mesenteric lymphatic glands of the calf were probably due to drinking the herd skimmilk. A litter of five pigs out of apparently strong and healthy parents, were killed last winter by one of us. All were tuberculous, and in one case it was generalized and far advanced. They had been fed on the mixed skimmilk of a cream-

32. British Medical Journal, I, 1889, 30.
29. Loc. cit.
30. Munchener Med. Wochenschr. 1889.
31. Publicatio.s Mass. Soc. Promot, Agr.

ery, and on two different occasions cows supplying this creamery had been tested and killed because of tuberculosis. Many of the pigs fed on the skimmilk of the Mountain View herd at East Burke, Vt., (78 out of 91 cattle found tuberculous by the tuberculin test and confirmed by post-mortem) were found when butchered to be as tuberculous as the cattle. At another farm where the Station veterinarian was called to use the tuberculin test, over sixty cows, over a hundred hogs, all the chickens, the dogs and even the family cat were exterminated because of this disease. The location of the disease at both ends of the line of cows in the Station barn, with but one diseased cow in the middle is suggestive in this connection.

Human tuberculosis is infectious.—This belief was held before the Christian era. About a hundred years ago the doctrine of hereditary transmission was advanced, but our present knowledge of its germ origin has forced the profession back to the old belief in infection with hereditary predisposition as an accessory cause. There are now scores of observations on record in medical journals which are positive evidence. Without going into details a few may be cited:

Italy's mild climate has long invited consumptives from every direction, who have so infected the country that even among its natives the disease is almost epidemic and its consumption death rate higher than that of any other European country.

"Prison consumption is notorious. Kennan[33] reports it to be a great scourge in Siberian prisons. There is usually a greater proportion of this disease in "institutions" than where human life is less seggregated. Cornet[34] found during twenty-five years in thirty-eight cloisters, 2,099 nuns acting as nurses had died. Of these, 1,300 or sixty-three per cent. had died of tuberculosis, or four and a half times the usual percentage. This seemed due almost entirely to their greater exposure to infection."

A recent example close at hand may be found in the report for 1893 of Dr. J. B. Ransom,[35] physician of the State's Prison at Dannemora, Clinton County, New York. He states that the percentage of total deaths from tubercular disease in that prison is over 80 per cent. In a private letter to one of us he states that he does not connect this with the milk supply, which is but small per man.

"In a lying-in hospital in Berlin was a nurse whose business it was to resuscitate children who were born asphyxiated by breathing into their lungs. Of ten infants so treated every one died of tuberculosis. This nurse died and upon examination showed that her lungs were tuberculous. The children were shown to have been born of healthy parents.[36]"

Three Grecian surgeons injected the sputa of a consumptive into the thigh of a fisherman whose death from gangrene was inevitable. Previous to injection they examined and found the lungs sound and

33. Century Magazine, June, 1889, p 172.

34. Zeit. fur Hygiene, VI. 1,64.

35. Annual Report of Supt. Prisons of the State of New York for 1893, p 181; also Report Proc. National Prison Assoc. 1894.

36. Berliner Klinische Wochenschrift, No. 37, 1878.

healthy. He had no known hereditary predisposition to tuberculosis. In three weeks the lungs showed signs of disease, and at death (from gangrene) in thirty-eight days after injection, seventeen tubercles were found at the summit of the right lung, two on the upper part of the left lung and two on the liver.[37]

Eight cases of consumption occurring within a few months in an English convent were traced to a single case. There had been no isolation, but all had slept in the same general dormitory. On isolation of the sick and proper disinfection the disease stopped.[38]

Biggs[39] cites a case reported by Schwenninger. Tappeiner conducted experiments on dogs causing them to breath air artificially infected with tubercle baccilli. His servant not believing in the danger and disregarding warnings, persisted in entering the inhalation chamber. He was free from hereditary predisposition, robust and healthy. He died of acute tuberculosis in fourteen weeks, and an autopsy showed the same lesions as those found in the dogs.

Dr. Dewevre of Paris noted that three brothers, all his patients, successively sickened and died of tuberculosis. They had shared the same bed, and were all bed-bug bitten. He found this bed over-run with bed-bugs, and learned that it had been thus infested for five years. Thirty bugs were caught and put upon three healthy guinea pigs, all of which soon died, and post-mortems showed well-marked tuberculosis. From the diluted and filtered pulp of fifty crushed bed-bugs bacterial cultures were obtained which caused typical tuberculosis when inoculated.[40]

Flies have sometimes been known to disseminate anthrax and other germ diseases. It is also claimed that they eat and disseminate tuberculous sputa, that the germ may be found in their bodies[41] and that fly specks carefully removed from the material to which they clung and injected have caused tuberculosis in guinea pigs [42].

A cook in removing a glass sputum cup broke it and a splinter of the glass punctured her finger. Two weeks later a swelling appeared, which grew until finally amputation was necessary. Examination showed numerous miliary tubercles containing the characteristic tubercle bacilli[43].

A young surgeon, Laennec[44] by name, had a somewhat similar experience. He wounded the index finger with a saw blade while cutting a tuberculous vertebra. A small rounded tumor with the physical characteristics of tubercle appeared at the spot and was removed.

Dr. Eve[45] relates the cases of two children circumcised when eight daysold in the Jewish manner by a tuberculous rabbi. In one case at six weeks tubercular swellings developed and in five months caseous abscesses formed, the material of which injected into guinea pigs induced general tuberculosis. The other child showed similar symptoms.

Dr. H. C. Ernst[46] stated that he "had here something like two thou-

37. Gazette Medical de Paris, No. 17, 1872.

38. London Medical Record, July 15, 1884.

39. Buffalo Med. and Surg. Journ. June, 1890.

40. Cressy: Report on Sanito-Veterinary Investigations; 27th An. Report Conn. Bd. Agr. p. 24.

41. Spillman and Haushalter: La Semaine Medical, Oct. 15, 1887; also Gazette hebdom. de Med. et de Chir.

42. Hoffman: Deutsche Med. Zeit. July 16, 1889.

43. Tscherming: Progress Med. 1885.

44. Abhandlungen von den Krankheiten der Lungen, Leipzig, 1832. Said to be the first recorded successful inoculation with tuberculous matter.

45. Lancet, Jan. 28, 1888,

46. Hearing on the "Dangers to Human Life from Bacilli of Tuberculosis in Milk" before the Committee on Public Health of the Massachusetts Legislature of 1891.

sand references to articles written in all languages, and in different parts of the world, bearing upon and proving the infectious nature of tuberculosis, including only the literature extending over about the past seven years."

Human and Bovine Tuberculosis are identical. The germs, the lesions, and in many respects the symptoms are the same. Lower animals inoculated with the tuberculous products of man contract the disease, the results are precisely the same as when the products of other animals are used, and the microscope shows the same germ present. Dogs, cats and poultry have in many cases on record[47] become infected from eating human sputa, while guinea pigs inoculated with fresh or dried sputa, or forced to inhale the dust of dried sputa, have succumbed to tuberculosis. There is no reason to believe that larger animals may not as readily be infected in the same manner.

Human tuberculosis infects the lower animals, and, what is vastly more important, and the central fact which prompts the publication of articles of this nature, BOVINE TUBERCULOSIS INFECTS MAN.

BOVINE TUBERCULOSIS TRANSMISSABLE TO MAN.

It is obvious that direct experiment on man with tuberculous material from the lower animals is out of the question. There are on record, however, a number of cases of accidental infection of human beings by the products of tuberculous cattle. There is reason to believe that countless thousands of deaths have occurred due to this source of infection, which have not been thus ascribed and of which no record has been made. Children are more likely to be infected than adults, owing to their tissues being less resistant and because their chief food is milk. It should not be inferred, however, that disease and death of necessity follow the consumption of tuberculous meat or milk. The following are some of the authenticated cases of accidental infection which have come to our notice. It is not to be inferred that they are of necessity all or the strongest on record.

Dr. Anderson of Seeland, reports a case of a babe fed on the milk of a cow having tuberculosis of the udder. The child died at six months with tuberculosis. The mother also developed symptoms of the disease after the child's birth. It was considered that both contracted the disease from the cow's milk.[48]

Ollivier,[49] at a meeting of the Academie de Medicine of Paris, stated that a patient of his, a young woman twenty years old, of vigorous health and without constitutional trouble, had acute tubercular menin-

47. Peters; Vet. Journal XVIII, 1887, p. 394: Nocard; Recueil de Med. Vet. annexe, 1888, 537; *ibid*, 1889, 66; *ibid* 1885 annexe, 93; LaMallerée; La Semaine Med. 1888, and others. See also 6th and 7th Reports Bureau of Animal Industry, 1888-1890, p. 47-48.

48. Hatch Exp. Station of Mass. Ag'l College, Bul. No. 3, p. 15.

49. Bacteriological World, Aug. '91,; transalated from Allgem. Med. Cent. Zeit.; also La Semaine Médical, Paris, Feb. 25, 1892.

gitis (inflammation of the membranes of the brain of tubercular origin). She had been educated at a boarding school where thirteen pupils had been ill of and six had died of tuberculosis within a few months. The milk supplied to the school was from cows kept on the place. Upon examination these animals were found to have tubercular ulcers on their udders, and, after being slaughtered were found to be generally tuberculous.

A Scotch family, all of sturdy health, had a herd of cattle which developed tuberculosis. Two daughters, being young, were brought up on the milk. Their two older brothers were more fond of whiskey than of milk. They are living healthy and hearty, while their two sisters are lying in their graves, victims of tuberculosis[50].

In the practice of Dr. Stang of Amorback, a well-developed five-year-old boy, from sound parents, whose ancestors on both sides were free from hereditary taint, succumbed, after a few weeks illness, with acute miliary tuberculosis of the lungs and enormously enlarged mesentric glands. A short time before the parents had their family cow killed and found her the victim of advanced pulmonary tuberculous[51].

Dr. Demme records the cases of four infants in the Child's Hospital at Berne, the issue of sound parents, without any tuberculosis ancestry, that died of intestinal and mesenteric tuberculosis, as the result of feeding on the unsterilized milk of tuberculous cows. They were the only cases in which he was able to exclude the possibility of other causes for the disease, but in these he was satisfied that the milk was alone to blame[52].

The infant son of a college mate of one of us, a comparatively strong and healthy child of twenty-one months, visited his uncle for a week. While there he drank the unsterilized milk of a cow which was soon after condemned and killed in a state of generalized tuberculosis. A few weeks after his return the child began to fail, and died three months after the fatal visit, a mere skeleton, with tabes mesenterica, or consumption of the bowels. Both of the child's grandfathers had died of tuberculosis when over sixty years of age, as well as two grand aunts and one grand uncle. The child never saw but one of these, and him but two or three times, and for short intervals only. A second child brought up on[53] sterilized milk is in robust health. Both parents are in excellent health.

A child four years old, great grandson of Henry Ward Beecher died last March at Yonkers, N. Y., of tubercular meningitis. The diagnosis was confirmed by specialists. There were no hereditary tendencies to the disease known. The certainty that he had the disease, and the inability to account for it from human agencies, led the physicians to suspect the milk of two Alderney cows, on which the child had been mainly fed. Both the tuberculin test and the post-mortems showed that both animals were tuberculous. Through the kindness of Dr. J. S. Lamkin of Yonkers, who made both tests and post-mortems, sections of the lungs and a gland were sent to us. They were found to be highly tuberculous[54].

May 30, '79, a cow died of generalized tuberculosis in Providence, R. I., the lungs, most of the abdominal viscera, muscular tissue and udder being tuberculous. The milk had been used in the family. In August, the baby was taken sick and died in seven weeks of tubercular meningitis. Postmortem showed tubercular deposits in the membranes covering the brain, and some in the lungs. Two years later a two-year-old child in the same family died of tubercular bronchitis, and seven years later a nine-

50. Discussion on Tuberculosis, Meeting Nat. Vet. Assn. London, May '83; Extracted from Lecture to Md. Sanitary Council by Dr. Robt. Ward, 1886, p. 10.

51-52. Law: Cornell University Exp. Stat. Bul. No. 65, p. 137.

53. Private letter to J. L. H.; also reported by Law, *ibid.* p. 137.

54. N. Y. Sun, March 29, '94. Also private letters to J. L. H.

year old boy, "delicate" for years, died of "quick" consumption. So far as known the family on both sides were rugged and healthy[55].

Dr. H. M. Pond[56] reports four cases of tuberculosis in one family, of which three were fatal. He considered the milk of their cows to be the source of the disease, since those animals were apparently tuberculous.

In the spring of 1890, Dr. Gage, city physician of Lowell, Mass., had as a patient an infant which died of tubercular meningitis. Its parents were healthy, and surroundings good. It had never been fed anything but the milk of a single cow. The cow's milk was microscopically examined and found to contain the bacilli of tuberculosis. Guinea pigs inocculated with her milk developed the disease. A second child, fed upon the same milk, was developing similar symptoms to those discovered in the child that died. Dr. Gage could find no way to prevent the sale of the milk unless he bought and paid for the cow out of his own pocket. So far as he knew she was still being used for a milk supply a year later[57].

The following cases of infection from eating meat or direct inocculation may be cited[58]. A woman whose ancestors were without tuberculous taint, ate eleven chickens bought from a neighbor. These chickens had been in the habit of greedily eating the spittle of their consumptive owner. They were but slightly roasted before eaten. The woman soon developed a well-marked case of tuberculosis of the bowels.

Dr. Treon[59] describes the poor, emaciated, diseased animals furnished to the tribes of Northwestern Indians, how they eat the liver, tallow and entrails raw and fresh, and how the carcass is dried, pounded and packed in skins to be eaten later, uncooked, even though the animal died of disease. The Indian mortality from consumption is 50 per cent. of all deaths at several points, while at Crow Creek, Dakota, 50 out of the total Indian population of 1200 die yearly of consumption and scrofula[60].

Dr. Washington Matthews[61] spent twenty-one years among the Indians. He states that their food is the primary cause of disease among them, and that when the supply of fresh beef is liberal the consumption death rate is highest.

A gentleman after eating something infected with tuberculosis has a nodule of tuberculous tissue form upon his tongue[62].

Tscherming attended a veterinarian who cut his finger during a post-mortem on a tuberculous cow. An ulcerated swelling formed, which on removal proved to be tuberculous and contained the characteristic bacilli[63].

Law[64] reports a case in his personal experience precisely parallel with Tscherming's.

Pfieffer attended a veterinarian of good constitution, without hereditary predisposition; who cut his right thumb deeply during a post-mortem on a tuberculous cow. The wound healed, but remained swollen. A year later pulmonary tuberculosis had developed, and in two and a half years after the wound the man died. Post-mortem examination showed tuberculosis of the joint of the wounded thumb and of the lungs[65].

55. Ernst: Report to Mass. Soc. Promot. Agr., p. 4; also reprint in Hatch Exp. Stat. Bul. No. 8, p. 16.

56. Pacific Med. & Surg. Jour. 1888.

57. Ernst: Hearing before Committee on Public Health, Mass. Legislature of 1891; Publications Mass. Soc. Promot. Agr., p. 19.

58. La Malleree:—La Semaine Med. 1888.

59. Amer. Practitioner; quoted by Law, *ibid* p. 131.

60. Holder:—Medical Record, Aug. 13, 1892, quoted by Law, *ibid*, p. 131. Scrofula is usually of tuberculous origin.

61. Census of 1880.

62. Ernst: Hearing, etc., p. 6.

63-64-65. Law, *ibid*, p. 318.

Dr. Ernst[66] sent a letter of inquiry to about 2000 medical men and veterinarians of the highest standing. "Out of 1200 or 1300 answers received but two expressed an absolute disbelief in milk as a vehicle for the virus of tuberculosis; there were a large number who expressed their belief in it: a large number who stated, what is perfectly true, the difficulty of proving such a thing, but expressed their belief in it; and a comparatively small number who furnished me with cases which they believed were distinctly traceable to the milk coming from tuberculous cows.

I have records of cases of probable infection of children from the milk of mothers with tuberculosis of the lungs and mamma. I have cases of the infection of chidren from milk coming from tuberculous cows. I have a large number of cases from veterinarians showing the infection of calves from tuberculous cows; and it seems to me that the amount of evidence obtained from the clinical side is very great."

Dr. E. O. Shakespeare, Ex. U. S. Cholera Commissioner says: "With all its terrors, it (cholera) is not nearly so deadly as is tuberculosis." [67] and "It has been found that in infants and young children in some large cities the mortality from some form of tuberculosis is far greater than is generally believed, amounting, in some localities, to one-fifth of the deaths in the young The significant fact in this connection is that it is most frequently some part of the digestive passages that became first affected."[68]

In this connection by way of negative evidence it is interesting to compare the geographic distributation of cattle and tuberculosis. Dr. E. F. Brush[69], of Mount Vernon, N. Y., has given years of study and investigation to this matter, and in his papers, scattered through the New York Medical Journal, makes the statement that tuberculosis does not exist among people which do not employ milch cattle. The inference to be drawn is not that human tuberculosis comes mainly from cattle, for man gets his infection mostly from his fellow man, but that possibly the primary source of infection, and more or less of its maintenance and extension are due to cattle. Whatever be the inference, there is little question that human consumption is relatively less prevalent in countries where there are few or no cattle, (Hebrides, Iceland, Newfoundland, Algiers, interior Southern Africa, parts of Ecuador and Peru and islands of the Pacific) and where reindeer, (Northern Norway, Sweden, Finland, Lapland, Greenland) goats or mares (Kirghis Steppes) furnish the milk. In some of the western South American countries cattle are used only for beef, since "so many cases of consumption have been traced to its (milk) use, that the entire population (of Eastern Peru) with scarcely a single exception, leave it entirely alone"[70].

66. Ernst, ibid, p. 9.

67. Report 4th Annual Meeting Farmers Inst. New Castle Co. Delaware, p. 16.

68. Medical News, March 26. 1892.

69. N. Y. Med. Jour.; "Bovine Tuberculosis," March 24, '88, pp 314-317; "The Relationship existing between Human and Bovine Tuberculosis," June 15, '89, pp. 645-650; "On the Coincident Geographical Distribution of Tuberculosis and Dairy Cattle," March 8, '90, pp. 253-256, "Sterilized Milk," June 20, '91, pp. 719-721; "One of the Apparent Reasons why Man is afflicted with Tuberculosis," Dec. 10, '92, pp. 657-659.

70. De Kalb in "Nation." Quoted by Bact. World, 1-3 p. 217.

Is the milk of a cow dangerous if the udder is not affected? Authorities differ. Koch[71], Nocard[72] and others failed to infect animals with milk from tuberculous cows whose udders were unaffected. On the other hand, Bang[73], Bollinger[74], Hirschberger[75], Ernst and Peters[76], Smith and Kilbourne[77] and Law[78] have succeeded in infecting animals with the milk of tuberculous cows with apparently sound udders. In Bang's work most pains-taking microscopical examinations of the udders of six cows giving infectious milk failed to show lesions. The conclusions drawn by Ernst and Peters from their careful work at Mattapan, Mass., are:

1st. And emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

2d. That the virus is present whether there is disease of the udder or not.

3d. That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

4th. That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk of cows affected with tuberculosis but with no discoverable lesion of the udder.

The fact that bovine tuberculosis may be transmitted to lower animals is absolutely proved by hundreds of positive experiments, and that it may likewise infect human beings through association and by their consumption of meat and milk, while not proved by direct, positive, intentional experiment, is placed practically beyond doubt by many observations of accidental infection.

Can the germ be killed and tuberculous meat and milk be made safe to eat by cooking?

The beef muscle is seldom affected, but the small lymphatic glands between the muscles, commonly cut and eaten in steaks and roasts are often diseased. The flesh itself of the pig is affected, and tuberculous pork is much more dangerous than tuberculous beef. The interior of a rare roast or steak is not heated to a point to insure safety, but all germs in a well done or well-boiled piece are usually killed.

71. Loc cit.

72. Recueil de Med. Vet. annexe 1885, p. 49.

73. Deutsce Zeit f. Thiermed XI-45, 1885, also Congress pour l'etude de la Tuberculose 1888.

74. Deutsche Zeit f. Thiermed XIV 264.

75. Deutsche Arch. f. Klin. Med. XLIV 600; also Internat. Klin. Rundschau, Sept. 22, '90.

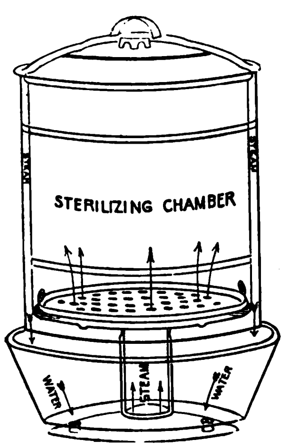
76. Trans. Assoc. Amer. Phys: IV, 1886. Report to Mass. Soc. Promot. Agr.; Hatch Agl. Exp. Sta. Bul. 8.

77. Bureau of Animal Industry, But. 3; also 8th and 9th Reports same, p. 64.

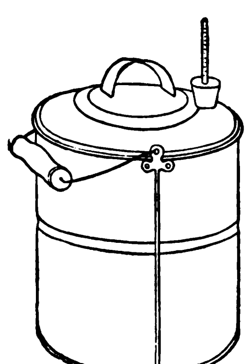
78. Cornell Univ. Exp. Stat., Bul. 65, p. 136.

If milk be boiled for half an hour, or heated by steam to 212°F practically all germ life will be destroyed. If heated to 150° to 167°F for half an hour to an hour and then cooled (rapidly if possible), the growth of such disease producing germs as are not killed is retarded for a period of twenty-four hours or more. The albumen is not coagulated at these temperatures, the milk is more palatable and digestable than if sterilized and is practically safe for prompt use. Pasteurized milk will not keep quite as long as sterilized milk. *Either sterilization or pasteurization is highly desirable with milk intended for children*, and is not a serious task. If bottles, one-half to three-fourths full of milk, are steamed for half an hour in a common steamer on the kitchen stove, all disease germs will be killed. The mouths of the bottles should be then plugged with clean absorbent cotton or cotton wool, as soon as removed from the steamer in order to keep all germs out. Half pint beer bottles with patent stoppers, costing sixty cents a dozen, are used in the family of one of us, and the milk is pasteurized with the stoppers closed as suggested by Cary[79]. A good milk sterilizer complete may be bought for from two to three dollars.

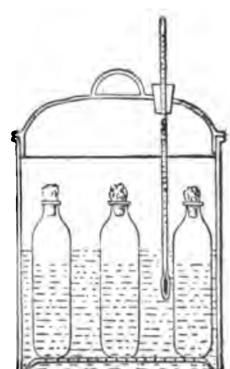
Three different models of milk sterilizers are shown herewith. The "Arnold" sterilizer (A) is made by Wilmot Castle & Co., 14 Elm St., Rochester, N. Y., and sells, with bottles, for $2.50. A recent modification of this apparatus enables pasteurization or sterilization in the same apparatus. The sterilizer recommended by Cary is shown at B. A copper sterilizer of this pattern with six patent stopper bottles (shown in cut) made to order in Burlington cost $2.30. The third cut (C) is kindly loaned by the Bureau of Animal Industry, and illustrates a yet cheaper but effectual form of sterilizer.

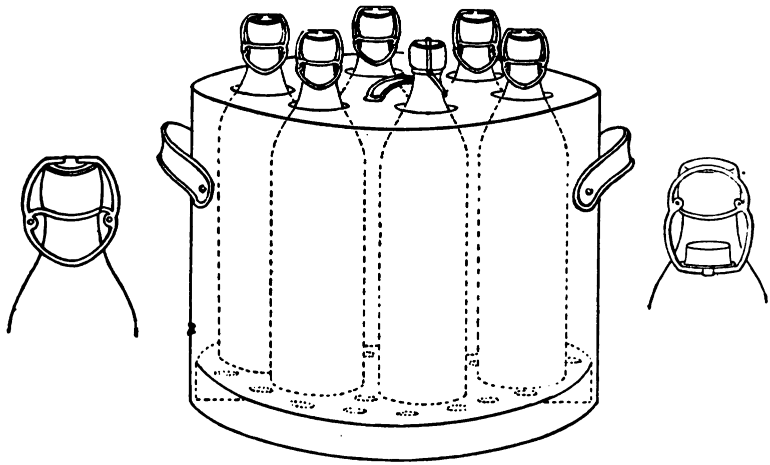


A



C





B

Dr. Law[80] points out a hitherto unappreciated source of danger in the use of the products of tuberculous animals even after complete sterilization. He draws a distinction between tubercular poisoning and tubercular infection. The product of the life of the tubercle bacillus is tuberculin. Its ptomaines, being lifeless, are not killed, but are intensified by heat. This material being generally diffused throughout a tuberculous subject exists in its products. Hence, those consuming its products, even though they are sterilized, are taking small doses of tuberculin, and, if they are already tuberculous, the effect may be to stimulate and extend the disease. The transmission of the germ is admitted to be more common from man to man than from animal to man. Though thus implanted, its subsequent destructive progress may be largely due to the constant accessions of the soluble poisonous products of tuberculous meat and milk, without which the implanted germ might have lain dormant. The reasoning from known facts is logical, and Dr. Law's point seems well taken. If this be true, it goes far towards explaining why tuberculosis is comparatively rare in countries where cattle are few. It tends to place the blame for the extension, if not for the inception of disease upon the bovine species.

Were it not for the use of tuberculin as a diagnostic agent the consumer might be considered to be between the devil and the deep sea, with tubercular infection on the one hand and tubercular poisoning on the other.

The reader should neither infer that there is of necessity more bovine tuberculosis now than in years past, nor that the danger to human life is greater. If some of the customs of modern life have increased our dan-

79. Alabama Agl. Exp. Station. Bul. 53.

80. Ibid. p. 138.

gers, others have decreased them. We are hearing more about tuberculosis now than ever before, simply because we know more about it. But so long as the human death rate from this disease remains at its present height, it will be profitable to continue to discuss measures for its prevention. Nor should our dairymen and breeders become needlessly alarmed. Probably not one animal in thirty throughout the State has the disease, and there are thousands of herds entirely free. What we need is simply that all realize the nature and conditions of the disease and of its spread. This done they can breed and care for their stock understandingly, weed out suspects at once, disinfect where needed, in short, use all possible precautions to avoid the disease. To this end a full, free, temperate and intelligent discussion is invited.

Is bovine tuberculosis curable? The usual opinion is that treatment is of little avail, that it is troublesome and costly, and that the results are unsatisfactory. Some believe that climatic change benefits cattle as it does mankind. It is true that the steers of the high altitudes of the West are practically free from this disease It is doubtful, however, whether it would pay to try climatic change upon many animals or whether Western stock owners would admit confessedly tuberculous animals among their hitherto unaffected stock. The proverb "An ounce of prevention is worth a pound of cure," is applicable to this disease. We may look forward to curative measures in the future, but at present the means are not known.

8. PREVENTION.

Since the results of curative treatments are unsatisfactory, and prevention is the watchword, *how may the disease be most surely prevented? Both human and bovine tuberculosis are distinctly preventable.* The measures that may be taken to prevent its spread are, briefly:

1. Rigid official inspection of cattle, meat and milk.

2. The immediate destruction or sterilization of human sputa and all tuberculous discharges.

3. The careful disinfection of rooms, hospital wards, barns, etc., occupied by tuberculous men or animals.

Though thus briefly summed, the execution of these measures involve a mass of details. Sumptuary laws are always difficult to enforce and questions of possibility and expediency should enter into consideration before enactment. "The fountain cannot rise higher than its source," and until the people thoroughly appreciate the dangers and understand the cause and means of prevention of tuberculosis, its control will be difficult.

The following precautions will be found useful by the stock owner in weeding out or keeping out tuberculosis.

1. The cow stable should be light, well ventilated and dry, the water pure and fresh, the feed nutritious and plentiful, the breeding judicious, with due regard to constitution.

2. So far as possible cattle should be kept from licking each other, from eating from the same manger and from interchange of mangers.

3. Suspected animals should be isolated, should neither eat nor drink from a common manger or drinking trough, nor should their orts be fed to other cattle. Old cows, those having husky or rattling cough, wheezy breathing, nasal discharge, enlarged glands under the skin, diseased udder, garget (sometimes), diseased joints, etc., unthriftness in general, cattle with weak constitutions and poor physical conformation (narrow chest, light barrel, long legs, pot bellies, etc.), are most open to suspicion. Such animals should be examined by a skillful veterinarian, and in case of doubt should be tested with tuberculin. If a single animal shows tuberculosis, the whole herd should thus be tested.

4. No new animal should be admitted from herds in which contagious disease has existed, from city or swill stables, or that shows signs of disease or unthriftness, unless tuberculin tested. It is almost equally desirable that unsuspected animals also be thus tested.

5. No consumptive person should work with live stock or prepare their food.

6. All tuberculous animals should be killed and their carcasses either burned or deeply buried in places where animals have no access.

7. Disinfection should be thorough and extend to all products of and articles used by the cattle. The means used at this Station were burning sulphur in the closed stable, washing or spraying every square inch of surface with a solution of one part corrosive sublimate in one thousand parts of water and the replacing of all the wood-work of the mangers. *Corrosive sublimate is a violent poison and should be used with care.*

The following directions for disinfection will be found useful in cases of animal disease :

1. Remove and burn all loose litter, hay, rubbish, etc.

2. Wash all mangers, hay racks and all wood work with a dilute solution of corrosive sublimate as stated above.

3. Whitewash all the inside of the building, especially mangers, hay racks, etc., and all wooden utensils used in the barn with a white wash containing one pound of chloride of lime to four or five gallons of water.

4. Remove and burn all rotton wood work, particularly about the mangers, drinking troughs, etc. It is advisable to replace these even if sound.

9. RELATION OF THE STATE TO TUBERCULOSIS.

The relation of the State to contagious and infectious animal diseases is a question on which there is wide diversity of opinion and practice. The most effectual work in the suppression of animal disease is that done under governmental supervision since it is more apt to be done in a systematic, intelligent and thorough manner. The National government has recently stamped out contagious pleuro pneumonia in cattle, but tuberculosis is wide spread, more insidious, more difficult to diagnose and cannot be thus easily handled. The experience of other States in this matter may prove instructive.

We have obtained this data by correspondence with the officials in charge of this work in the various States.

Maine New Hampshire, Massachusetts, Maryland, Ohio, Indiana, Illinois, Michigan, Kansas, Colorado and Missouri have Boards under various names, essentially Cattle Commissions. In Vermont, Rhode Island, Connecticut and Pennsylvania the Boards of Agriculture, or a committee of the same, act as Cattle Commissioners. In New York, New Jersey, Minnesota and Tennessee the State Boards of Health attend to this matter. Most of the Southern states and some of the far Western states exercise no control whatever over animal disease. Some of the Boards have veterinarian members, some do not. All however employ veterinarians.

Data was obtained from all the States having controlling boards east of the Mississippi, with the exception of Wisconsin.

State.	Does State law especially mention tuberculosis; if so in what way?	Is it customary to give indemnity; if so how much? How is apprisal made?	How does Board regard indemnity system.	How does Board handle tuberculosis if reported?	Do you use tuberculin? How do you like it? Do post-mortems confirm test.
Ontario, Canada.	Yes, as an "infectious or contagious disease."	Not in Ontario. In certain circumstances the government grants compensation.	Favorably.	Same as other diseases.	Yes, approve. Post-mortems always confirm.
Maine.	Especially tuberculosis.	Yes; half limited apprisal.	Highly favorable.	Same as other diseases, inspection, apprisal etc.	Yes, very much, invariably.
New Hampshire	Especially tuberculosis.	Yes; half limited apprisal.	Favorably.		Yes, well, reliable.
Vermont.	No.	Law permits; present Board have only given for glanders	Unfavorably.	Free veterinary service and free tuberculin, but no indemnity.	Yes, much, yes.
Massachusetts.	Yes, special act.	Half limited apprisal.	Not very favorably.	Examination and slaughter if affected.	Not as a Board.
Rhode Island.	Yes, section 10 chapter 1082.	Yes; half limited apprisal; three apprisors one being commissioner and one veterinarian.	Favorably.	Same as other diseases.	Not as a Board. No. No.
Connectic't	No.	Yes, actual sick value; 3 appraisors; 1 named by owner, 1 by State, 2 choose 3d.		Investigate, as with other disease.	Yes, in one herd. Results satisfactory.
New York.	Yes, special act.	Yes; apprisal by owner's selected apprisors; referred to court of claims.		With glanders by State Board Health, while other contagious cattle diseases are handled by Com. of Agriculture.	Yes. 20,000, injections. Liked well. 3½ per cent. cattle tested found tuberculous.
New Jersey.	No.	Half limited disinterested apprisal.			Not as a Board.
Penns'lvna	No.	Yes; limited apprisal.	Highly favorable, "would not undertake to enforce a law without."	"Use tuberculin; 'advise' slaughter; do not condemn for then we have to pay. They are killed in 90 per cent. of cases."	Yes; "safe in proper hands" "known of no error but will accept from no one but our own surgeon. Post-mortems have in all cases shown the disease".

State.	Does State Law especially mention tuberculosis, if so in what way?	Is it customary to give indemnity; if so how much? How is appraisal made?	How does Board regard indemnity system?	How does Board handle Tuberculosis if reported?	Do you use Tuberculin? How do you like it? Do post-mortems confirm test?
Maryland.	No.	No.	Favorably it under national auspicies.	Report it to State Board Health.	Not yet. Awaiting development of use elsewhere.
Ohio.	No.	No.	No funds.	Do not handle.	No.
Indiana.		No.	No funds.	Only handled few cases.	No.
Illinois.	No.	Glanders only.	Favor indemnity at sick value.	Only handled few cases.	No.
Tennessee.	No.	Yes.	Favorably.	No.	No.
Michigan.					
Minnesota.	No.	No.	Unfavorable.	Isolate, use tuberculin and forbid sale of products or as food.	Yes. Supply it to local boards.
Kansas.	No.	No.	Not considered.	Not recognized by law as contagious.	Not as a Board.
Colorado.	No.	Yes; limited appraisal by 3 disinterested appraisors; 1 furnished by State and 2 choose 3d. $1000 in a year is State limit.	"Absolutely necessary in order to detect existence of disease and have it reported."	State is free from tuberculosis.	No.
Oregon.					Yes. Yes.
Missouri.	Yes. Law enables quarantine.	Only for glanders.	Favorable.	Inspect, and if infected quarantine.	Not as a Board.

Of the states having occasion to deal with bovine tuberculosis which reported, six pay little attention to it. New York, Pennsylvania and Minnesota have taken the most advanced grounds regarding its suppression. Of the fifteen State Boards answering the question regarding the opinion held by the Board of the indemnity system, nine were favorable to it, three did not consider it owing to lack of funds, and three did not favor it. Maryland, Ohio, Indiana, Minnesota, Missouri, Kansas, the Southern States and most of those of the far West have no indemnity system, while the laws of all the New England and Middle States permit it.

The arguments for and against the indemnity system may be summed up briefly as follows:

1. The indemnity system encourages the disclosure of the existence of disease and favors its more complete eradication, while the absence of some

such system leads to the concealment and dispersion of disease. In many cases the comparatively small expenditure for indemnity distributed among many tax payers is truer economy than the losses in life and money, caused by animal diseases which have been concealed.

2. The indemnity system recognizes the rights of property.

3. Since the public is benefited in being guarded against disease, it should bear its share of the cost of that protection.

On the other hand:

1. The indemnity system is apt to encourage disease. The stock owner is less careful if he can rely on the State to purchase his infected animals, even though at a low rate.

2. Diseased animals are often collected at a low figure from other owners and other States for the purpose of getting indemnity from the State.

3. It is liable to become a burden to the tax payer.

4. The State essentially insures breeders and owners against their mistakes and misfortunes. While it is hard to lose property in any form, a diseased animal is a nuisance. There should be no question between a loss of dollars and the not improbable ruin of the health of human beings.

From the standpoint of disease eradication only, there is no question that a liberal indemnity promptly paid is preferable to any other course.

The Bureau of Animal Industry of the Department of Agriculture at Washington, is employed in a thorough investigation of tuberculosis using a special appropriation of $100,000 for the purpose. An English Parliamentary Commission has been considering the matter for nearly three years and is expected to report this year. The Danish government has taken an advanced stand, and in April 1893, appropriated $13,000 for the purpose of inaugurating a thorough system of tuberculin tests throughout the Kingdom. Disinfection and separation are to be used and a strong fight against bovine tuberculosis will be made.

The Legislature of 1892, abolished the board of cattle commissioners and placed the execution of the statutes regarding cattle diseases in the hands of the State Board of Agriculture. The following circular has been issued by that Board explaining their attitude towards tuberculosis, copies of which, with bond, may be obtained of any of the members of the Board on application.

OFFICE OF CATTLE COMMISSIONERS,

BRANDON, VT.

Dear Sir:

The attention of cattle owners, and the public generally, is being attracted towards the disease called Tuberculosis. This is a very old disease among cattle, dating to the Middle Ages, and is almost identical with consumption in the human family, and is transmittable, under favorable con

ditions, from the human family to cattle, and from cattle to the human family by means of the germs of disease contained in the sputum thrown from the lungs in coughing. It is also claimed that the disease is conveyed to the human family by the use of the dairy product of tuberculous cows, the truth and extent of which is now being tested by experiments. The disease is usually of slow progress and difficult to detect by exterior appearance except in advanced stages, or when located in the lungs.

It has recently been claimed by scientists that Koch's Lymph, called Tuberculin, is a means of detecting the disease, even when not apparent from any outward test.

The Bureau of Animal Industry offers to furnish a limited amount of the Lymph to the different Experiment Stations and Cattle Commissions, provided they will slaughter such cattle as the Lymph indicates have the disease, and report to Washington.

There are at the present time many experiments being made to test the danger to the human family from the use of the dairy product of tuberculous cows; also to test the efficacy of the Lymph as a certain and safe guide for its detection.

On account of the unsettled conditions connected with this disease, the Board of Cattle Commissioners do not feel warranted in taking extreme grounds, but are willing to aid science in offering the services of an expert in applying the tuberculin to any herd where it may seem advisable —provided the owner of such herd will agree to slaughter and allow the examination of all that respond to the tuberculin test, without compensation from the State.

C M. WINSLOW,
VICTOR I. SPEAR,
J. O. SANFORD,
H. W. VAIL,
J. L. HILLS,
H. M. ARMS, } Board of Agriculture.

OFFICE OF CATTLE COMMISSIONERS,

BRANDON, VT.

Dear Sir:

In consideration of free veterinary services and free use of tuberculin supplied by the State Cattle Commission, in response to my application to them for inspection of my dairy herd, I do hereby agree—

To slaughter all animals declared by the veterinarin to be tuberculous, at such time and place as he shall appoint; to allow him to make post-

mortem examination of such slaughtered cattle; to afford him such assistance in slaughter and preparation for post-mortem as he may require—with the distinct understanding that I shall not hold the State of Vermont-or any person or persons, or the Board of Cattle Commission ers, individu ally or severally, liable for payment for any animal or animals so slaughtered.

Signed,

Witness.

V. BIBLIOGRAPHY.

The following list comprises all the publications on the general subject of tuberculosis issued by American Experiment Stations, the Bureau of Animal Industry of the Department of Agriculture, and most, if not all,of those issued by the Cattle Commissions of the New England and Middle States and Ontario. Most of these publications, (if in print) may be obtained free upon application.

EXPERIMENT STATIONS.

Delaware (Newark)—Fifth Annual Report. Consumption in Milch Cows (Bovine Tuberculosis); A. T. Neale; pp 49-52, 3 pages.

Maine (Orono)—Annual Report 1890, Part II.; Report on Tuberculosis; F. L. Russell; pp 59-64 6 pages.

Bul. No. 13, June 1894; The suppression of bovine tuberculosis and glanders; F. L. Russell, 7 pages.

Massachusetts, (Hatch Station, Amherst)—Bul. No. 3, Jan. 1889; Tuberculosis; C. H. Fernald; 20 pages.

Bul. No. 8, April 1890; How far may a cow be tuberculous before her milk becomes dangerous as an article of food. Extract from Report to Mass. Soc. Promote Agr.; H. C. Ernst; pp 13-24, 12 pages.

New Jersey (New Brunswick) Bul. No. 101, July, 1894, also Annual Report, 1893; On the Use of Koch's Lymph in the Diagnosis of Tuberculosis in Cattle; J. Nelson; 77 pages, 5 plates.

New York, (Cornell Station, Ithaca)—Bul. No. 65, April, 1894; Tuberculosis in relation to Animal Industry and Public Health; James Law; pp 103-157; 54 pages.

Pennsylvania (State College, Centre Co.)—Bul. No. 21, October, 1892; The Koch Test for Tuberculosis; H. P. Armsby and L. Pearson; 19 pages.

Vermont (Burlington)—Bul. No. 42, July 1894; Bovine Tuberculosis; J. L. Hills and F. A. Rich; pp 17-70, 54 pages, 4 plates.

Virginia (Blacksburg)—Bul. No. 26, March, 1893; Tuberculosis and the Koch Test; E. P. Niles; pp 55-60; 6 pages.

Bul. No. 32, Sept. 1893; The cow in relation to public health; E. P Niles; pp 119–126, 6 pages.

Wisconsin (Madison), Bul. No 40, July 1894; Tuberculosis and the Tuberculin Test; H. L. Russell; 47 pages.

Canada (Ottawa, Ontario)—Bul. No. 20, February, 1894; Tuberculosis; Wm. Saunders and J. W. Robertson 36 pages.

UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY, WASHINGTON, D. C.

First Annual Report (1884); Report on Tuberculosis, International Veterinary Congress, Brussels, 1883; pp 350-366, 17 pages.

Fourth and Fifth Annual Reports (1887-1888); Various items concerning tuberculosis; p 499, 1 page.

Sixth and Seventh Annnal Reports (1889-1890); Tuberculosis in Domesticated Animals; pp 45-62, 17 pages.

Eighth and Ninth Annual Reports (1891-1892); Experiments with the milk of tuberculous cattle; pp 63-65, 2 pages; Tuberculosis in cattle; pp 102-103, 1 page; Tuberculin; pp 106-107, 2 pages.

Special Report on Diseases of Cattle and Cattle Feeding (1892); Tuberculosis; D. E. Salmon and J. T. Smith; pp 398-408, 11 pages.

CATTLE COMMISSIONS, ETC.

Maine (Portland); Reports of Commissioners on Contagious Diseases of Animals, 1888, 1889, 1890, 1891, 1892.

New Hampshire (Concord); First and Second Annual Reports of the State Board of Cattle Commissioners of New Hampshire, 1891, 1892.

Vermont (Brandon); Fourteenth Annual Report of the State Board of Agriculture, 1893-94; see also (Brattleboro) Report of the Twenty-second Annual Meeting of the Vermont Dairymen's Association (1892); Tuberculosis; Dr. Austin Peters.

Massachusetts (Boston); Reports of Cattle Commissioners in Reports of State Board of Agriculture, 1880, 1886, 1887, 1889, 1891, 1893.

Rhode Island (Providence); Report of State Board of Agriculture, 1892.

Connecticut (West Cornwall); Reports of Commissioners on Disease of Domestic Animals in Reports of State Board of Agriculture, 1879 to 1893

inclusive; Reports for 1879 and 1887 also contain addresses on the subject by Dr. N. Cressy.

New York (Albany); Report of State Board of Health, 1891, 1892, 1893.

New Jersey (Trenton); Circular 50, State Board of Health; Reports of State Board of Health in Reports of State Board of Agriculture, 1891, 1892, 1893.

Pennsylvania (Harrisburg); Reports of State Board of Agriculture, 1885, 1886, 1891, 1892.

Delaware (Newark); Reports of the Third (1892) and Fourth (1893) Annual Meetings of the Farmers' Institute of New Castle Co.

Ontario (Toronto); Report on Tuberculosis in Ontario, presented to the Provincial Board of Health, etc., by P. H. Bryce, Secretary; the Milk Supply Problem, by P. H. Bryce, Secretary; Diagnosis of Tuberculosis by J. J. MacKenzie.

FURTHER EXPERIENCE WITH TUBERCULIN.

By J. L. Hills and F. A. Rich.

I. *In the Experiment Station Herd.*—Warned by the severe experience with tuberculosis, noted on pages 21-29, the Station officers have exercised all possible care to prevent further disease. All accessions to the herd were tested with tuberculin before admission and have been and are to be re-tested twice a year. The present herd was bought in three lots in April and October, 1894, and January, 1895. The April lot has now been tested thrice, the other two lots, twice. The results of the tests are compiled in the following table. Temperatures above 104° are printed in blackface, (except in the case of Flora's first test, when the cow, having just calved, and having been driven nine miles, showed high temperatures.)

NAME.	DATE OF TEST.	Average Normal Temperature.	TEMPERATURE TAKEN AFTER INJECTION.							Highest Test Temperature.	Rise of Highest Test Temperature over Normal.
	April 16-17....	101.	101.6	101.6	101.5	101.4	101.2	101.	.....	.....	101.6	0.6
Julia.........	Oct. 29-30.....	101.	101.5	101.4	101.6	101.5	101.8	101.5	101.6	101.4	101.8	0.8
	June 12-13....	101.6	100.6	101.	101.2	101.	101.	.....	.....	.....	101.2	—0.4
	April 16-17....	105.5	102.6	103.8	104.	104.1	104.4	104.5	.....	.....	104.5	—1.
Flora.........	Oct. 29-30.....	101.2	101.6	102.	101.8	101.8	102.2	101.8	101.6	101.6	101.8	0.6
		At	past	ure.								
	April 16-17....	101.4	101.6	101.5	101.8	101.6	101.6	101.8	.....	.....	101.8	0.4
Fanny........	Oct. 29-30.....	101.8	102.2	102.	101.6	102.	102.2	101.8	101.6	101.8	102.2	0.4
	June 12-13....	101.3	101.4	101.5	101.8	101.	.....	.....	.....	.....	101.8	0.5
	April 16-17....	101.4	100.8	102.	101.5	101.5	101.4	101.2	.....	.....	102.	0.6
Jessie.........	Oct. 29-30.....	101.8	102.	102.6	103.4	103.5	103.5	103.	103.	103.	103.5	1.7
	June 12-13....	101.6	101.	101.6	102.	101.8	.....	.....	.....	.....	102.	0.4
	April 16-17....	101.8	101.8	102.	102.	102.2	102.2	102.	.....	.....	102.2	0.4
Fairie.........	Oct. 29-30.....	101.4	100.4	101.5	101.4	101.8	102.	101.6	101.6	101.2	102.	0.6
	June 12-13....	101.4	101.2	101.4	101.8	101.4	.....	.....	.....	.....	101.8	0.4
	April 16-17....	100 5	101.6	101.6	101.4	101.4	101.	100.6	.....	.....	101.6	1.1
Dandelion	Oct. 29-30.....	101.	101.	100.8	101.6	101.8	10 .8	101.4	101.4	101.8	101.8	0.8
	June 12-13....	101.7	100.8	101.4	101.2	101.2	.....	.....	.....	.....	101.4	—0.3
	April 16-17....	100.8	101.	101.2	101.2	101.2	100.8	101.6	.....	.....	101.6	0.8
Jennie........	Oct. 29-30.....	101.6	102.2	102.5	103.	103.	103.2	103.	103.2	102.8	103.2	1.6
	June 12-13....	101.3	101.2	101.4	101.4	101.4	.....	.....	.....	.....	101.4	0.1
	April 16-17....	101.	101.4	101.	101.	101.	100.6	100.8	.....	.....	101.4	0.4
Belle Black...	Oct. 29-30.....	101.	101.	101.	101.4	102.	101.8	101.8	101.6	101.6	101.8	0.8
	June 12-13....	Sold										
	April 16-17....	100.6	101.8	102.	102.	101.8	101.8	100.6	.....	.....	102.	1.2
Violet	Oct. 29-30.....	100.8	101.	101.2	101.	101.2	101.6	101.5	101.2	101.5	101.6	0.8
	June 12-13....	Sold										
	April 16-17....	101.4	101.6	101.6	102.2	101.4	101.4	101.6	.....	.....	102.2	0.8
Bess..........	Oct. 29-30.....	101.8	101.8	101.5	101.8	102.	102.	101.8	101.8	101.6	102.	0.2
	June 12-13....	101.7	100.6	101.4	101.2	101.	.....	.....	.....	.....	101.4	—0.3
	April 16-17....	101.8	100.8	100.6	101.	100.6	101.4	101.1	.....	.....	101.4	0.6
Dora..........	Oct. 29-30.....	101.6	101.	100.5	101.	101.2	101.4	101.5	101.2	101.	101.5	—0.1
	June 12 13....	100.5	101.	101.	101.6	101.	.....	.....	.....	.....	101.6	1.1
	April 16-17....	100.6	102.	102.4	102.2	102.	102.4	101.6	.....	.....	102.4	1.8
Red Top......	Oct. 29-30.....	101.	101.6	101.6	102.4	102.5	101.8	101.8	101.8	101.8	102.5	1.5
	June 12-13....	101.2	101.8	101.	101.	101.6	.....	.....	.....	.....	101.6	0.4
	April 16-17....	101.6	102.2	102.	101.8	101.6	101.2	101.2	.....	.....	102.2	0.6
Clover........	Oct. 29-30.....	101.2	101.6	101.8	101.8	102.	101.8	101.8	101.8	101.5	102.	0.8
	June 12-13....	At	past	ure.								
	April 16-17...	101.6	102.	101.4	101.2	101.2	101.	101.2	.....	.....	102.	0.4
Brownie......	Oct. 29-30.....	101.8	101.6	102.2	102.2	102.	102.	101.8	102.	102.	102.2	0.4
	June 12-13....	101.3	100.6	100.8	101.6	101.2	.....	.....	.....	.....	101.6	0.3
	April 16-17....	101.4	101.2	101.	101.	100.6	100.6	101.2	.....	.....	101.2	—0.2
Maizie........	Oct. 29-30.....	101.	101.	101.4	101.2	101.4	101.5	101.5	101.5	101.6	101.6	0.6
	June 12-13....	101.2	100.6	100.8	101.2	101.2	.....	.....	.....	.....	101.2	0.0

NAME.	DATE OF TEST.	Average Normal Temperature.	TEMPERATURE TAKEN AFTER INJECTION.								Highest Test Temperature.	Rise of Highest Test Temperature over Normal.
Golden Rod...	April 16-17....	101.2	101.2	101.2	101.	101.	101.	101.	.....	.....	101.2	0.0
	Oct. 29-30.....	102.4	101.6	102.	102.	102.4	102.	101.8	101.8	101.8	102.4	0.0
	June 12-13....	100.9	100.6	101.	101.6	101.	.....	.....	.....	.....	101.6	0.7
Rowena	April 16-17...	101.4	101.4	101.8	101.8	101.6	100.8	101.4	.....	.....	101.8	0.4
	Oct. 29-30.....	101.8	102.2	102.5	102.4	102.2	102.	102.2	101.8	101.6	101.4	1.8
	June 12-13....	At	past	ure.								
Bettie	April 16-17....	102.3	101.6	101.2	101.2	102.5	103.	102.	.....	.....	103.	0.7
	Oct. 29-30.....	102.2	102.8	101.5	102.	101.8	101.8	101.5	101.4	101.4	102.	—0.2
		At	past	ure.								
Blossom......	Jan. 1........	101.5	102.	101.9	102.	101.	101.8	101.6	101.3	101.	102.	0.5
	March 21-25...	100.7	101 2	101.4	102.5	102.2	102.2	102.	102.5	100.8	102.5	1.8
	Oct. 29-30.....	102.	103.	103.6	103.5	104.5	104.4	105.5	105.	105.4	105.5	3.5
Gretchen.....	Jan. 1........	101.	101.9	101.9	101.8	102.	101.8	102.5	102.5	102.3	102.5	1.5
	March 24-25...	100.8	101.6	101.	100.8	100.4	100.	100.2	100.8	100.	101.6	0.8
	Oct. 29-30.....	100.8	101.7	103.3	104.	105.	105.2	105.8	105.4	105.4	105.8	4.0
Lolita.........	Jan. 1........	102.4	102.7	102.8	103.3	103.2	104.5	103.3	103.5	103.6	104.5	2.1
	March 24-25...	101.3	102.5	102.5	101.5	101.5	101.8	102.5	102.5	.....	102.5	1.2
	Oct. 29-30.....	101.	101.2	101.6	101.8	102.2	102.2	102.	101.6	101.8	102.2	1.2
		Sold										
Rena Myrtle..	Jan. 1........	101.7	102.1	102.4	102.	101.9	102.	102.	101.8	101.8	102.4	0.7
	March 24-25..	101.2	101.2	102.2	102.2	102.	101.5	101.8	102.	101.6	102.2	1.
	Oct. 29-30.....	100.6	101.8	102.5	101.8	102.	102.2	101.8	101.	101.7	102.5	1.9
	June 12-13....	100.9	101.	101.6	102.	101.8	.....	.....	.....	.....	102.	1.1
Jim...........	June 26-27....	101.6	100.8	101.6	101.5	100.	101.2	.....	.....	.....	101.5	—0.1
	June 12-13....	101.6	100.5	100.4	100.8	101.2	.....	.....	.....	.....	101.2	—0.4
Acme.........	Oct. 28-29.....	101.4	103.2	102.4	102.	102.2	102.1	102.	.....	.....	103.2	1.8
	June 12-13....	101.9	101.5	101.8	101.8	101.8	.....	.....	.....	.....	101.8	—0.1
Atalanta......	Oct. 28-29.....	101.4	101.6	101.6	101.8	102.6	102.8	102.2	.....	.....	102.8	1.4
	June 12-13....	101.5	101.4	101.4	100.6	100.8	.....	.....	.....	.....	101.4	—0.1
Nancy B......	Oct. 29-30.....	102.5	101.5	101.5	102.5	102.	101.8	103.2	.....	.....	103.2	0.7
	June 12-13....	102.7	101.8	101.8	102.	102.2	.....	.....	.....	.....	102.2	—0.5
Nett..........	Nov. 7-8......	101.6	101.8	101.8	101.4	101.5	102.2	.....	.....	.....	102.2	0.6
	June 12-13....	101.8	101.4	101.	101.4	101.	.....	.....	.....	.....	101.4	—0.4
Jersey Lily...	Oct. 3-4.......	101.4	101.8	101.6	101.8	101.5	102.	.....	.....	.....	101.8	0.4
	June 12-13....	101.7	102.	101.6	101.6	101.8	.....	.....	.....	.....	102.	0.3
Regina........	Oct. 3-4.......	101.4	101.4	101.2	101.2	101.5	101.2	.....	.....	.....	101.5	0.1
	June 12-13....	101.	101.2	101.2	101.6	101.	.....	.....	.....	.....	101.6	0.6
Portelette....	Oct. 3-4.......	101.8	101.8	101.8	101.8	101.8	101.6	.....	.....	.....	101.8	0.0
	June 12-13....	101.3	101.2	101.2	101.2	101.	.....	.....	.....	.....	101.2	0.1
Waxy	Oct. 3-4.......	101.	101.8	101.4	101.	101.	101.4	.....	.....	.....	101.8	0.8
	June 12-13....	101.4	101.6	101.2	101.6	101.2	.....	.....	.....	.....	101.6	0.2
Jessaline	Oct. 3-4.......	101.2	102.	102.	102.	102.	102.2	.....	.....	.....	102.2	1.0
	June 12-13....	101.3	100.4	100.6	101.4	101.2	.....	.....	.....	.....	101.4	0.1
Eulalie........	Oct. 3-4.......	102.4	102.6	102.8	102.4	102.	102.6	.....	.....	.....	102.8	0.4
	June 12-13....	101.	100.6	101.4	101.	100.8	.....	.....	.....	.....	101.4	0.4
Kinkora	Oct. 3-4.......	102.2	102.	101.1	101.8	101.4	102.	.....	.....	.....	102.	0.2
	June 12-13....	101.8	101.	101.5	101.8	101.6	.....	.....	.....	.....	101.8	0.0
Lady LeBrocq	Oct. 3-4.......	100.5	102.6	102.6	102.	102.2	101.8	.....	.....	.....	102.6	2.1
	March 11-12...	100.6	100.6	101.2	102.	101.8	102.	.....	.....	.....	.....	1.4
Rhoda........	Oct. 3-4.......	100.6	101.2	101.8	102.	101.8	101.	.....	.....	.....	101.8	1.2
	June 12-13....	101.4	101.4	102.2	101.2	102.4	.....	.....	.....	.....	102.4	1.0
Goldie........	Oct. 3-4.......	101.6	102.	102.	102.	100.6	101.5	.....	.....	.....	102.	0.4
	June 12-13....	102.	102.	101.6	102.	101.6	.....	.....	.....	.....	102.	0.0
Effie..........	Jan. 16-17.....	101.4	101.	102.2	102.	101.6	.....	.....	.....	.....	102.2	0.8
	June 12-13....	101.5	100.8	100.4	101.4	101.5	.....	.....	.....	.....	101.5	0.0
Flox..........	Jan. 16-17.....	102.2	101.	101.	101.	101.	.....	.....	.....	.....	101.	—1.2
	June 12-13....	101.	100.6	101.	101.2	101.2	.....	.....	.....	.....	101.2	0.2
Idarella.......	Jan. 16-17.....	101.6	102.	101.2	101.8	101.5	.....	.....	.....	.....	102.	0.4
	June 12-13....	102.	101.6	101.8	101.8	101.8	.....	.....	.....	.....	101.8	—0.2
Lena..........	Jan. 16-17.....	101.4	101.	101.5	101.4	101.2	.....	.....	.....	.....	101.5	0.1
	June 12-13....	102.5	102.	102.4	102.	102.6	.....	.....	.....	.....	102.6	0.1
Kittie	Jan. 16-17.....	101.6	101.	101.6	101.8	101.6	.....	.....	.....	.....	101.8	0.2
	June 12-13....	101.8	101.2	101.4	101.	101.6	.....	.....	.....	.....	101.6	—0.2
Marjory......	Jan. 16-17.....	101.4	100.6	101.	101.6	101.8	.....	.....	.....	.....	101.8	0.4
	June 12-13....	101.3	100.6	100.8	101.6	101.6	.....	.....	.....	.....	101.6	0.3

It will be seen that *none of the cattle of our new herd reacted on the first, second or third injections*. Two remaining members of our former herd, Blossom and Gretchen, reacted at the October test and were slaughtered. The post mortems showed the following organs to be diseased:

Blossom, lungs (very slight), retropharyngeal, bronchial and mesenteric and portal glands; liver (bad).

Gretchen, lungs (very slight), retropharyngeal, bronchial and mesenteric glands.

The continued good health of the new herd is reason for congratulation, and is evidence of a negative nature that properly prepared and carefully handled tuberculin cannot cause tuberculosis.

II. *In the State.* The Station veterinarian has made about 2400 injections, mainly in connection with the Cattle Commission. The results of the first half of this work are shown on pages 30-31 of this report. Since that summary 1023 Vermont cows have been tested and 96 killed. Omitting two herds largely infected we find that of 949 Vermont cows tested 49 were killed and found tuberculous in every case. These were in 84 different herds. Uniting the data we find 1809 Vermont cattle, 234 tuberculous; omitting four herds largely infected, 1611 Vermont cattle, 88 tuberculous. We wish once more to call attention to the fact that *this ratio should not be thought of necessity to indicate the percentage of tuberculous cattle in the State*, for the injections were usually made in herds where there was reason to suspect the existence of the disease. The distribution of the disease in 215 autopsies, the records of which are on hand at the present writing, is as follows: lungs, 80 per cent; pleura, 7 per cent; bronchial glands, 66 per cent; retropharyngeal glands, 24 per cent; mediastinal glands, 8 per cent; peritoneum, 5 per cent; mesenteric glands, 33 per cent; intestines, 9 per cent; liver, 30 per cent; portal gland, 20 per cent; spleen, 2 per cent; udder, 23 per cent; super mammary glands, 24 per cent; prescapular gland, 4 per cent; generative organs, 1 per cent.

III. The enforcement of the Massachusetts tuberculosis law of 1894 has caused much heated discussion in the daily and agricultural press of the New England States. Much bad blood has been shown and many claims made which are without basis in fact. The use of tuberculin without the owners consent has been the bone of contention in Massachusetts, and the law recently (June 1895,) passed has followed the new Vermont law in restricting its use. The ground taken by those who oppose the use of tuberculin is essentially as follows: bovine tuberculosis is less prevalent and less infectious than is claimed; tuberculin is not successful as a diagnostic since mistakes are sometimes made in its use and because it may cause the disease or injure the cows. No attempt is made here to consider in detail all of the objections raised by the opponents of tuberculin. Several of these are quite fully considered on pages 48-51 of this report. It seems probable from our experience in Commission work that tuberculosis is not as prevalent in Vermont as in some other localities, but that there is enough to warrant the passage of

the law which gives the Commission the power to keep the disease out, to shut it up and to gradually weed it out. The infectiousness from one animal to another has been shown so many times in our work that we thoroughly believe eradication to be the best economy. The failure of tuberculin to give correct results is probably generally due to its use in inexperienced hands or to surroundings which excite the cows thus rendering accurate work difficult. There is little if any evidence to support the claim that properly prepared and carefully used tuberculin can cause tuberculosis, while there is reason for believing that it sometimes has a curative effect. There is much evidence, some obtained at this Station, based on the slaughter of healthy animals, injected more or less frequently with test doses of tuberculin, tending to prove the impossibility of infection from tuberculosis. The following data tends to prove that *the tuberculin test does not dry up the cows.* Fifteen cows tested Jan. 1, 1894, gave 2484 pounds during ten days preceeding and 2417 pounds during ten days following the test, a shrinkage of but three per cent. Sixteen cows tested October 30, 1894, gave 2858 pounds during the ten days preceeding, 2760 pounds during the ten days following, and 2613 pounds during the next ten days, being 3 and 9 per cent shrinkage. Sixteen other cows in the same barn, on the same dates (October 20 and November 18) of the year previous (1893) and not tested, gave 2801, 2476 and 2411 pounds during similar ten days periods, larger shrinkages than found with the tested cows of 1894. The change from pasture to barn life occurred early in November each year, and makes the shrinkage larger than would normally occur. All of these cows were members of the Experiment Station herd, and include all where we have the data showing yields prior to test.

Letters were written to owners of herds of ten or more animals tested with tuberculin by the Commission asking whether injurious effects or shrinkage of the milk yield had been observed, resulting from tuberculin. Forty-two out of forty-nine replied. Eight noted temporary shrinkages in from one to three milkings; none noted permanent shrinkage. One thought his cows injured, while forty-one reported no ill effects whatever.

The agitation of the past year has been termed a "craze," a "fad." There probably has been in some cases more fear than was warranted. Yet a disease which causes a seventh of the total human death rate, which is unquestionably sometimes communicated from the animal to the human, and which, when once established in a herd, if unchecked, endangers the health and life of each member is too important a matter to be ignored. The Vermont farmers, as a rule, however, have upheld the Commission in its work, and the present law seems fairly satisfactory. Whatever the outcome may be, the agitation has resulted in a large diffusion of education on this matter Stockowners will be more liable to buy and breed cautiously, to better feed and care for their cattle, to watch more vigilantly for symptoms of ill health and to weed out suspects when found, thus securing healthier herds and better dairy products.

Abstracts of Bulletins.

BULLETIN NO. 41. ANALYSES OF COMMERCIAL FERTILIZERS. (1894.)

BY J. L. HILLS AND B. O. WHITE.

I. SUMMARY.

1. The trade values of fertilizing ingredients in mixed goods in 1894 are 18½ cents per pound for nitrogen; 6, 5½ and 2 cents per pound for soluble, reverted, and insoluble phosphoric acids; 5¼ and 4½ cents per pound for sulphate and muriate of potash.

2. *These trade values do not represent the proper selling prices of mixed goods at the point of consumption*, but are the retail cash prices, of the various fertilizing ingredients in the large markets unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance.

3. The Station has analyzed samples of fifty-three distinct brands of fertilizers, all taken this spring from dealers' stocks and all 1894 goods. This is seventeen more than have been analyzed in any previous year. Most of these seventeen are believed to be new in the State this year. So far as is known by the Station all but three brands sold in the State have been sampled and analyzed.

4. Of the 53 brands analyzed, 18, or one-third, are above guarantee in nitrogen, available phosphoric acid and potash; 28, or one-half, are deficient in a single ingredient; 6, or one-ninth, are deficient in two ingredients; 1 is below guarantee throughout. Of the 35 brands found deficient, 27 show by their analysis imperfect mixing at the factory. They contain a sufficient excess of other ingredients to afford an equivalent money value. It is safe to say that five-sixths of the brands sold in the State this year contain the commercial equivalent of their guarantees. The percentage of failure to meet guarantee is greater than has hitherto been found in this State.

5. The comparison of the average composition of the fertilizers sold in the State in 1894, with those of the past ten years shows that the goods are of poorer quality than any sold during this time. The average selling price is lower than ever before, being 85 cents less than last year, but the average valuation is $1.62 less than in 1893, based on the same (1894) trade values.

6. Since 1885 over ninety different brands of fertilizers have been sold in Vermont. Selling prices have dropped 17 per cent, and valuations 20 per cent. The per cent of cost over valuation was least in 1889, and is most now. Owing to the lower prices of nitrogen and phosphoric acid the buyer does not pay as much now for plant food as ten years ago, yet he pays more than at any time during the past six years.

7. Nineteen samples of ashes varied from 0.43 to 7.66, per cent soluble potash, from 1.02 to 2.19 per cent phosphoric acid and from 2.25 to 67.40 per cent insoluble matter and sand. The prices for these goods were not in accordance with their composition. It is always best to buy ashes on the analysis of the Experiment Station.

ANALYSES OF LICENSED FERTILIZERS.—(1894.)

Station Number.	Brand.	Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Nitrogen. Valuation at Station Prices.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available Found.	Phosphoric Acid. Available Guaranteed.	Phosphoric Acid. Valuation at Station Prices.	Potash. Found.	Potash. Guaranteed.	Potash. Valuation at Station Prices.	Station Number.
1158	Bowker's F'rm & Gard'n Phosphat	1.12	....	0.75	1.87	1.5	$6.92	3 07	4.77	2 87	10.71	10	7.84	8	$10.08	2.47	2	$2.22	1158
1146	" Hill and Drill Phosphate	0.65	0.40	1.38	2.43	2.5	8.99	4.88	4.72	2.35	11.95	12	9.60	9	11.97	2.14	2	1.93	1146
1084	" Potato Phosphate. ..	0.73	0.11	1.04	1.88	1.5	6.96	4.23	3.57	2.93	10.72	11	7.79	9	10.17	2.06	2	1.85	1084
*1152	" " "	0.97	0.10	0.83	1.90	1.5	7.03	3 46	4.63	2 74	10.83	11	8.09	9	10.34	2.05	2	1.84	1152
1104	" Pot'to & V'g't'ble M'nure	1.17	.. .	1.07	2.24	2.5	8.29	4.51	4.02	3.54	12.07	10	8.53	8	11.25	4.68	4	4.21	1104
†1082	" St'ckbridge Corn M'nure	1.85	0.11	1.21	3.17	3.25	11.73	5.36	3.87	3.21	12.44	10	9.23	8	11.97	4.13	4	4.05	1082
†1147	" " Potato "	1.58	0.10	1.45	3.13	3.25	11.58	6.22	1.57	2.11	9.90	8	7.79	6	10.04	6.21	7	6.30	1147
1100	" " Top Dressing	2.35	0.10	2.51	4.96	5.	18.35	1 99	2 68	4.43	9.10	6	4.67	4	7.11	6.21	6	5.59	1100
1102	" Sure Crop Fertilizer....	0.40	....	0.43	0.83	0.75	3.07	3.00	5.23	4.04	12.27	10	8.23	8	10.97	1.08	1	0.97	1102
1129	Bradley's B. D. Sea Fowl Guano.	0.56	0.16	2.05	2.81	2.5	10.40	5.68	3.93	2.41	12.02	11	9.61	9	12.10	1.91	2	1.72	1129
1128	" Complete, Potatoes and Vegetables........	1.20	....	2.62	3.82	3.75	14.13	4.25	4.19	2.77	11.21	9	8.44	8	10.82	5.71	6	5.14	1128
†1099	" C'mpl'te Top Dress'g &c	2 66	....	2.52	5.18	4.95	19.17	1.34	3.74	1.67	6.75	6	5.08	5	6.39	2.99	2.5	3.11	1099
1095	" Corn Phosphate..	0.44	0.18	1.70	2.32	2.05	8.58	7.09	2.67	1 39	11.15	10	9.76	9	12.01	1.78	1.5	1.60	1095
1085	" Eclipse Fertilizer......	0.47	0.11	1 23	1.81	1.	6.70	5.41	4 54	2.07	12.02	12	9.95	10	12.31	1.62	1.5	1.46	1085
1081	" Potato Fertilizer.......	0.41	0.18	1.61	2.20	2.05	8.14	6.62	2.84	0.94	10.40	11	9.46	9	11.44	2.94	3.25	2.65	1081
1112	" " Manure........	1.15	....	1.00	2.15	2.5	7.96	5.05	1.44	1.02	7.51	8	6.49	6	8.05	5.12	5	4.61	1112
1073	" XL Superphosphate...	0.26	0.17	2.18	2.63	2.5	9.73	6.34	2.67	1.52	10.53	11	9.01	9	11.15	2.26	2	2.03	1073
1145	Clark's Cove Bay State Fertilizer	0.19	0.16	2.32	2.67	2.47	9.88	6 58	2.06	1.63	10.27	10	8.64	9	10.81	2.03	2	1.83	1145
1078	Cleveland's Corn & Grain "	0.39	0.14	1.87	2.40	2.05	8.88	6.12	2.62	1.79	10.53	10.5	8.74	9.5	10.94	1.73	1.5	1.56	1078

*Station No. 1152 was analyzed at the request of the manufacturers, who claimed that Station No. 1084 did not truly represent their goods.

†Potash in brands thus marked is in form of sulphate; in all others is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all the potash as such.

ANALYSES OF LICENSED FERTILIZERS.—(1894.)

Station Number.	Brand.	Nitrogen. From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Valuation at Station Prices.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Valuation at Station Prices.	Potash. Found.	Guaranteed.	Valuation at Station Prices.	Station Number.
1131	Cleveland Fertilizer for all Crops	0.47	0.11	1.53	**2.11**	**1.1**	**$7.81**	6.00	3.30	2.38	**11.68**	**9**	**9.30**	**8**	**$11.78**	**1.68**	**2**	**$1.51**	1131
1130	Cleveland Potato Phosphate....	0.39	0.13	1.91	**2.43**	**2.05**	**8.99**	6.00	3.03	2.00	**11.03**	**10**	**9.03**	**8**	**11.33**	**2.88**	**3**	**2.59**	1130
1087	Coe's Alkaline Bone..........	....	0.12	1.32	**1.45**	**1.23**	**5.37**	6.71	2.04	3.17	**11.92**	**11**	**8.75**	**9**	**11.56**	**2.28**	**1.6**	**2.34**	1087
1103	" Columbian Bone.........	....	0.11	1.20	**1.31**	**1**	**4.85**	6.52	2.29	3.19	**12.00**	**11**	**8.81**	**9**	**11.62**	**2.25**	**1.85**	**2.30**	1103
1092	" Grass and Grain Fertilizer	...	0.10	0.92	**1.02**	**0.85**	**3.77**	6.77	2.94	3.74	**13.45**	**10**	**9.71**	**9**	**12.85**	**1.65**	**1.35**	**1.70**	1092
1094	" High Grade Ammo. Bone	....	0.56	1.73	**2.29**	**2.05**	**8.47**	6.47	2.26	3.17	**11.90**	**11**	**8.73**	**9**	**11.52**	**2.12**	**1.85**	**2.06**	1094
1088	" XXV. Ammonia Bone....	...	0.10	1.48	**1.58**	**1**	**5.85**	7.28	3.21	3.36	**13.85**	**9**	**10.49**	**8**	**13.61**	**1.41**	**1**	**1.41**	1088
1071	Crocker's Ammo. Corn Phos....	....	....	2.27	**2.27**	**2**	**8.40**	6.78	2.37	1.03	**10.18**	**11**	**9.15**	**10**	**11.16**	**1.86**	**1.6**	**1.67**	1071
1124	Crocker's Ammo. Wheat & Corn	....	....	1.90	**1.90**	**2**	**7.03**	6.58	3.13	1.84	**11.55**	**11**	**9.71**	**10**	**12.08**	**2.09**	**1.6**	**1.88**	1124
1072	Crocker's New Rival Superphosphate..................	....	0 11	1.44	**1.55**	**1.2**	**5.74**	6.20	2.97	1.46	**10.63**	**10**	**9.17**	**10**	**11.29**	**1.94**	**1.6**	**1.75**	1072
1117	Crocker's Potato, Hop, etc.	...	....	2.26	**2.26**	**2**	**8.36**	7.14	1.99	1.78	**10.91**	**11**	**9.13**	**10**	**11.47**	**3.28**	**3.2**	**2.95**	1117
*1075	" " " ".....	...	....	1.98	**1.98**	**2**	**7.33**	6.59	2.32	1.97	**10.88**	**11**	**8.91**	**10**	**11.25**	**3.28**	**3.2**	**2.95**	1075
1080	" Special Potato.......	....	0.19	3.34	**3.53**	**3.7**	**13.06**	7.16	1.19	0.59	**8.94**	**9**	**8.35**	**8**	**10.14**	**5.63**	**5.4**	**5.07**	1080
1133	Cumberland Fertilizer.	....	....	1.19	**1.19**	**1.03**	**4.40**	4.61	3.05	2.10	**9.76**	**10**	**7.66**	**8**	**9.73**	**2.18**	**2**	**1.96**	1133
1110	" Potato Fertilizer...	0.40	....	1.87	**2.27**	**2**	**8.40**	5.02	2.55	1.75	**9.32**	**11**	**7.57**	**9**	**9.53**	**4.28**	**3**	**3.85**	1110
1106	" Superphosphate....	0.83	....	1.29	**2.12**	**2**	**7.84**	5.82	3.34	2.32	**11.48**	**10**	**9.16**	**8**	**11.59**	**2.14**	**2**	**1.93**	1106
†1123	Davidge's Potato Manure.......	....	....	2.49	**2.49**	**2.88**	**9.21**	7.94	1.68	0.68	**10.30**	**10**	**9.52**	**9**	**11.65**	**4.13**	**4**	**4.29**	1123
†1122	" Special Favorite for Cereals..........	....	....	1.23	**1.23**	**1.23**	**4.55**	4.15	5.21	3.15	**12.51**	**11**	**9.36**	**10**	**11.97**	**2.51**	**1.5**	**2.59**	1122

***Station Nos. 1071 and 1075 were analyzed at the request of the manufacturers, who claimed that Nos. 1124 and 1117 did not truly represent their goods.**

†Potash in brands thus marked is in form of sulphate; in all others is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all the potash as such. ‡Potash partly as sulphate.

ANALYSES OF LICENSED FERTILIZERS.—(1894.)

Station Number.	Brand.	Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Nitrogen. Valuation at Station Prices.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available Found.	Phosphoric Acid. Available Guaranteed.	Phosphoric Acid. Valuation at Station Prices.	Potash. Found.	Potash. Guaranteed.	Potash. Valuation at Station Prices.	Station Number.
1091	Lister's Success Fertilizer......	....	0.25	1.28	**1.53**	**1.23**	**$5.66**	7.43	1.46	2.61	**11.50**	**10.5**	**8.89**	**9.5**	**$11.57**	**2.11**	**2**	**$1.90**	1091
1090	P. G. Co.'s Sol. Pacific Guano...	0.50	....	1.81	**2.31**	**2.25**	**8.55**	5.80	2.83	2.13	**10.76**	**10.5**	**8.63**	**8.5**	**10.92**	**2.49**	**2**	**2.23**	1090
1111	" Spec. Potato Manure	0.93	....	1.54	**2.47**	**2.47**	**9.14**	4.44	4.03	1.28	**9.75**	**7**	**8.47**	**5**	**10.27**	**5.48**	**5**	**4.93**	1111
1134	Quinnipiac Climax Phosphate...	....	....	1.26	**1.26**	**1.03**	**4.66**	5.39	2.81	2.19	**10.39**	**9**	**8.20**	**8**	**10.44**	**2.42**	**2**	**2.18**	1134
1125	" Corn Manure......	....	0.10	2.33	**2.43**	**2.05**	**8.99**	6.27	3.83	2.11	**12.21**	**10**	**10.10**	**9**	**12.58**	**1.65**	**1.5**	**1.48**	1125
*1108	" Market Garden M're.	1.28	....	2.00	**3.28**	**3.30**	**12.14**	4.68	4.04	2.28	**11.00**	**9**	**8.72**	**8**	**10.97**	**6.08**	**7**	**5.47**	1108
1107	" Phosphate.......	....	0.12	2.36	**2.48**	**2.47**	**9.18**	7.01	2.60	0.85	**10.46**	**10**	**9.61**	**9**	**11.61**	**1.82**	**2**	**1.64**	1107
1121	" Potato Manure......	1.02	....	1.39	**2.41**	**2.47**	**8.92**	3.12	2.41	2.42	**7.95**	**7**	**5.53**	**6**	**7.36**	**4.73**	**5**	**4.26**	1121
1136	" Potato and Tobacco	0.69	0.14	1.39	**2.22**	**2.05**	**8.21**	6.39	3.16	1.15	**10.70**	**9**	**9.55**	**8**	**11.60**	**3.01**	**3**	**2.71**	1136
1076	Read's Bone, Fish and Potash...	1.07	0.25	1.40	**2.72**	**2.47**	**10.06**	2.76	1.43	0.48	**4.67**	**5**	**4.19**	**4**	**5.08**	**6.00**	**4**	**5.40**	1076
1096	" Farmer's Friend	0.64	0.11	0.94	**1.69**	**2.05**	**6.25**	5.73	2.93	1.98	**10.64**	**10**	**8.66**	**9**	**10.90**	**2.10**	**2**	**1.89**	1096
1077	" Leader Guano	....	0.11	1.07	**1.18**	**0.85**	**4.37**	4.18	2.92	1.35	**8.45**	**8**	**7.10**	**7**	**8.77**	**2.21**	**2**	**1.99**	1077
1097	" Standard............	....	....	0.97	**0.97**	**0.85**	**3.59**	5.78	2.05	1.63	**9.46**	**9**	**7.83**	**8**	**9.84**	**3.89**	**4**	**3.50**	1097
1150	Standard Fertilizer	....	....	2.06	**2.06**	**2**	**7.62**	5.74	2.76	2.51	**11.01**	**10**	**8.50**	**8**	**10.93**	**2.24**	**2**	**2.02**	1150
1151	" Guano..............	....	0.14	1.05	**1.19**	**1**	**4.41**	4.99	2.74	1.94	**9.67**	**10**	**7.73**	**8**	**9.78**	**1.87**	**2**	**1.68**	1151
1070	W. & C. Americus Ammo. Bone	....	0.12	2.37	**2.49**	**2.47**	**9.21**	6.06	3.50	2.12	**11.68**	**10**	**9.56**	**9**	**11.97**	**2.07**	**2**	**1.86**	1070
1119	" " Corn........	0.44	0.10	1.91	**2.45**	**2.55**	**9.07**	5.44	3.40	2.30	**11.14**	**10.5**	**8.84**	**9**	**11.19**	**1.91**	**1.5**	**1.72**	1119
1118	" Potato Phosphate....	1.01	...	1.51	**2.52**	**2.47**	**9.32**	3.04	2.75	2.47	**8.26**	**7**	**5.79**	**6**	**7.66**	**4.63**	**5**	**4.17**	1118
1114	" Royal Bone Phosphate.	....	0.10	1.08	**1.18**	**1.03**	**4.37**	4.31	0.91	2.10	**7.32**	**8**	**5.22**	**7**	**7.01**	**2.29**	**2**	**2.06**	1114

***The manufacturers claim that this sample does not properly represent their goods. The Station vouches for the sample and its analysis. No other sample of this brand was found.**

COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1893 AND IN 1894.

Of the fifty-eight brands of commercial fertilizers sold in the State during 1893 and 1894, thirty-one standard brands have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands were selected which have been sold in the State during both of the years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1893 AND 1894.

NAME OF INGREDIENTS.	1893.		1894.	
	Pounds in a Hundred.	Valuation at 1893 Prices.	Pounds in a Hundred.	Valuation at 1894 Prices.
Nitrogen	2.42	$8.95	2.18	$8.07
Soluble Phosphoric Acid	6.43	7.72	5.69	6.83
Reverted Phosphoric Acid	2.84	3.12	2.94	3.23
Insoluble Phosphoric Acid	2.29	0.92	2.01	0.80
Available Phosphoric Acid	9.27		8.63	
Total Phosphoric Acid	11.56		10.64	
Potash	2.72	2.45	2.90	2.61
Total valuation per ton		$23.16		$21.54

A comparison of the average compositions for the two years shows a very decided decrease in the quality of the goods sold this spring. The nitrogen has been lessened one-tenth, and the phosphoric acid one-twelfth. The potash has been increased one-fifteenth, but it should be remembered that it is commercially the least valuable of the fertiizing ingredients. The decrease in valuation is $1.62 while the average selling price has fallen less than a dollar. Organic nitrogen has increased in price, which in a measure explains the drop in nitrogen. Phosphoric acid however has become cheaper, yet less is placed in the average goods. The average composition is much lower than that of any previous year since the Station began sampling and analyzing licensed fertilizers under the State law.

The same decrease in quality this year will be found on reference to the tables on page 14, of the bulletin abstracted, showing average analyses of what might be called the standard brands of the State and of all brands analyzed. The manufacturers as a whole are crowding closer to their lower guarantees than hitherto, and competition has affected quality more than price.*

*The reader should note that these analyses and remarks apply only to the trade of 1894, and not to that of 1895, when (see Bulletin 47) plant food was cheaper than in the preceding year.

BULLETIN NO. 43. HOUSEHOLD PESTS.

BY G. H. PERKINS.

I. *Buffalo Beetle*. The Buffalo Beetle or Carpet Beetle is well known in Vermont in the larva state, but not as well known in the beetle state and is not always recognized when seen. It infests woolens but does not often do much damage to other substances. The larva which is the form commonly seen and most generally known as the Buffalo Beetle, has a hairy appearance. The perfect insect is a very small beetle, not as large as the larva, which is usually less than a fourth of an inch long, while the bettles are from 1-7 to 3-16 of an inch long and nearly as wide. The colors are black, white and red. There is an irregular red stripe along the middle of the back and from this are three narrowly triangular projections on each side. The antennae are composed of eleven joints the last three of which are much larger than the rest. The back is but little convex. The under side of the body is black dotted with red and white. It often pretends to be dead when disturbed.

Remedies. When once well established it is not easily dislodged, but with perseverance and care it can be driven out and kept out from even badly infested houses. If carpets are fastened down, a through lining with paper will prevent many of the larvæ, which hide in cracks and crevices, from getting at it. If larvæ appear, benzine may be poured about the edges of the carpet several times. An excellent remedy is corrosive sublimate, 60 grains, dissolved in a pint of alcohol or water and brushed over the floor at the edges before the carpet is laid, and also over the underside of the carpet. Children must not play upon a carpet so treated. A still simpler method said to be effective, is that of laying a damp cloth on the carpet at the infested edge and placing a hot iron on it. The steam penetrates the carpet and destroys the insects. Insect powders have no value as remedies in this case. Small articles and boxes, drawers, etc., may be freed from insect pests by benzine or by bisulphide of carbon, or may be wrapped in smooth, whole paper, or put into a paper bag and the opening sealed with paste, before the beetles have had a chance to deposit eggs upon the article, or larvæ to get at at it.

The Pitchy Carpet Beetle is often confounded with the Buffalo Beetle. It is a little larger, longer and narrower than the Buffalo Beetle. The larva is a hairy brown object with whitish rings between the joints, and at the posterior end is a long pencil-like tuft of hair. It is probable that some of the damage which has been ascribed to the Buffalo Beetle is the work of this species.

II. *Cloth Moths*. The moths are well shown in figures in the bulletin so that nothing need be said by way of description except as to color. The general color is light brown on the front wings and silver gray on the hind wings, or else light yellow with no dark wing spots.

Remedies: If clothing, etc., is enclosed in tight paper bags before moths begin to fly and lay their eggs it will be protected. Articles suspected may be sprinkled or sprayed with benzine which will destroy even the eggs. After spraying and airing, articles may be wrapped in papers or in bags. A few cents spent for paper bags is better than costly cedar chests or closets. furniture, etc., in constant use is not likely to be attacked. If stored, cover with paper or cotten cloth so as to leave no opening, or a spray with benzine or bisulphide of carbon early in June, and again in a month or six weeks.

SHOWING AVERAGE CONDITION OF FRUIT FROM SPRAYED AND UNSPRAYED TREES. (See details on page 87.)

Figure 3. One hundred Flemish Beauty pears from sprayed tree showing relative amounts of 1st and 2d class fruit.

Figure 4. One hundred Flemish Beauty pears from adjoining unsprayed tree showing relative amounts of 1st, 2d and 3d class fruit.

Figure 5. A perfect Potato Leaf, sprayed with Bordeaux mixture. (See page 95.)

Figure 6. A Potato Leaf showing holes eaten by Flea-beetles. (See page 95.)

Figure 7. A healthy hill of potatoes. Sprayed with Bordeaux mixture.

Figure 8. Not sprayed. The upper leaves cut off by Grasshoppers.

SPRAYED. NOT SPRAYED.

Figure 9. From photograph of Station potato plots made August 31. Showing beneficial effects of Bordeaux mixture chiefly from checking the Grasshoppers. (See page 97.)

BULLETIN NO. 44. SPRAYING ORCHARDS AND POTATO FIELDS.

By L. R. JONES.

I. SUMMARY.

II. The weather of 1894 was remarkably dry and as a result fungus diseases damaged crops less than usual. The loss from apple and pear scab was less than in most seasons. Potatoes at the experiment farm were practically free from blight and rot. Certain insects, especially flea-beetles and grasshoppers were unusually troublesome upon potatoes.

III. The scabbing and cracking of apples and pears is a fungus disease. The remedy consists in spraying the trees with Bordeaux mixture. Where this was done in 1894, the market value of the fruit was increased from one-fourth to one-half. All apple and pear trees should be sprayed once or twice with Paris green to destroy the codlin moth and other insects. Those varieties liable to scab should be sprayed in April before the leaves open with a simple copper sulphate solution, and at least three times in May and June with the Bordeaux and Paris green mixture.

IV. There was no appreciable loss from blights or rot upon our potato plots in 1894. Hence the gains from the use of the Bordeaux mixture was less marked than in former years. The use of this mixture was rendered profitable, however, by its beneficial effects in other ways, especially in preventing the injuries of flea-beetles and grasshoppers.

V. Early planted potatoes in Vermont form their tubers in July. This is usually the driest month of the summer and as a result the yield is small, the plants often dying prematurely. Later planted potatoes form their tubers in August and September, months in which the rainfall is usually abundant, and the yield is proportionally large. In order to preserve these later potatoes from the blight and rot they must be sprayed. Owing to the peculiar weather of 1894, early planted potatoes yielded most and late ones least. It is believed, however, that these conditions were exceptional and that the later planting is for the average season more profitable.

VI. Potato scab is a fungus disease. Preventive measures consist in selecting clean soil, using proper fertilizers, and planting none but clean "seed." If the seed is not known to be clean it should be disinfected with corrosive sublimate solution. This latter process added 50 per cent to our yield of marketable potatoes on one plot in 1894.

REPORT OF THE CHEMISTS.

BY J. L. HILLS AND B. O. WHITE.*

ANALYSES OF WOOD ASHES, MUCK, ETC.

Station Number.	Source.	RECEIVED FROM.	Soluble Potash.	Insoluble Potash.	Total Potash.	Total Phos. Acid.	Insoluble Matter.
1165	Canada.	E. O. Lee, Vernon........	4.64	....	....	....	.....
1166	"	F. H. Atwood, Westminster.....	4.32	1.26	5.58	2 17	.....
1167	"	" "	5.39	2.10	7.49	3.35	.....
1168	"	" "	4.81	2.40	7.21	2.88	.....
1169	"	J. W. Boyce, Guildhall.........	5.20	2.60	7.80	1.42	.....
1170	"	W. H. Cole, Westminster.......	4.34	1.54	5.85	1.97	.....
1171	"	J. W. Boyce, Guildhall.........	9.53	0.14	9.67	4 49	5.13
1172	"	Victor I. Spear, Braintree......	6.50	0.00	6.50	3.11	7.76
1173	"	A. N. Duncklee, South Vernon..	4.01	1.99	6.00	2.96	11.09
1174	Vermont.	" "	6.84	0.04	6.88	5 23	13.71
1175	"	C. A. Hinsdill, No. Bennington..	3.36	0.96	4.42	3.07	12.20
1176	"	" "	5.90	1.31	7.21	2.89	17.05
1177	"	" "	3.60	0.15	3 75	2.91	10.75
1178		F. H. Atwood, Westminster.....	5.21	1.15	6.36	....	.....
1179		" "	6.05	0.08	6.13	....	.....
1180	Limekiln.	W. B. Fonda, St. Albans........	3.86	0.44	4.30	1.49	.....
1181		H. A. Barker, Burlington.......	5.28	1.58	6.86	1.54	8.50

Seventeen samples of ashes varied from 3.36 to 9.53 per cent soluble potash and from 1.48 to 5.23 per cent phosphoric acid. The prices for these goods were not in all cases in accordance with their composition. It is always best to buy ashes on the analysis of the Experiment Station.

*It is but fair to say that the work reported under this head represents but a very small fraction of the actual time of the chemists, which is largely taken up by the analysis of fertilizers, fodders, dairy products, etc. These, or results and conclusions based upon these, appear in other portions of the report, as well as in several of the bulletins.

ANALYSES OF MUCK AND MISCELLANEOUS MATERIAL.

Station Number.	RECEIVED FROM	Moisture.	Ash.	Volatile and Organic.	Nitrogen.	Nitrogen in Dry Matter.	Phosphoric Acid.
1182	Muck, J. N. Baxter, Rutland......	87.96	.....	.....	0.29	2.42	.....
1183	" O. K. Fletcher, Hinesburgh..	80.23	.....	.....	0.27	1 37	.....
1184	" (Pond) F. F. Gilbert, Dorset.	49.12	.....	.....	1.23	2.41	.....
1185	" (Swamp) " "	33.15	.....	.....	0.84	1.26	.....
1186	" E. C. Orvis, Manchester....	51 22	10.52	38.26	1.37	2.81	.....
1187	" W. L. Sylvester, W. Brattleb'	57.00	31.65	11.35	0.63	1.47	....
1188	Odorless Guano, " "	2.23	.....	.....	0.63	.....	19.44
1189	Refuse Tannery Salt, M. V. Leach, Essex......................	14.80	.....	.....	0.23	0.27	0.14
1190	Liquid Refuse Soap Works, Essex..	91.00	.....	....	1.00	11.06	0.07

The column headed "Nitrogen in Dry Matter" best shows the relative value of the mucks. It will be noted that there is a wide range—one sample being twice as good as any one of three of the others. "Odorless Guano' (which should not be confounded with "Odorless Phosphate," an American' made Thomas Slag) is a soft Florida rock. The phosphoric-acid is almost entirely insoluble in water or ammonium citrate. The refuse salt was found to be almost worthless, and the soapwork refuse, to have, at current prices, a value of about three dollars.

Two samples of granite dust, received from Mr. George Cassie, of Barre, contained

	1	2
Phosphoric Acid (soluble in acid) -	trace	trace
Potash, " " - -	0.95	0.95
Potash, (soluble after fusion) - -	3.82	3.79

Mr. Cassie states that he has "noticed for the last few years that when stone chips and dust from granite is dumped around stone sheds the grass would grow pretty well along the edges. Muriatic acid is used in cleaning the stones. I have wondered if there was not some mineral quality in the fine dust screenings from stone chips from our stone sheds."

Potash is valuable when available to plants, but is in an exceedingly insoluble shape in granite dust. The amount of potash present in a ton of granite dust can be bought in the best and most readily available forms for $3.25 and as muriate will weigh but about 120 pounds. "Stone meal" is now advocated by some as a cheap form of plant food. It is probable that only under exceptionally favorable circumstances will this form of Vermont stone meal prove worth cartage. Mr. Cassie's land is thus favorably located and his use of granite dust will be watched with interest.

The following analysis represents a sample of Soluble Pacific Guano which was taken at the request of the owner, Mr. S. C. Otis, of West Burke, from a lot manufactured in 1881, and consequently fourteen years old. Compared with it is the average of two analyses of the same brand made by the Connecticut Experiment Station in 1881.

	Vermont analysis of Sol. Pacific Guano manufactured in 1881, analyzed, 1895	Average of Connecticut analyses, same brand, manufactured and analyzed in 1881.
Nitrogen	1.72	2.49
Soluble Phosphoric Acid	6.91	6.60
Reverted Phosphoric Acid	2.46	1.44
Insoluble Phosphoric Acid	2.02	3.72
Available Phosphoric Acid	9.37	8.04
Total Phosphoric Acid	11.39	11.76
Potash	2.49	2.02

It is not claimed that the comparison is entirely fair, yet the analysis serves to show that perhaps with the exception of the nitrogen the quality of goods does not of necessity deteriorate by long standing.

ANALYSES OF DRINKING WATER.

Thirty-six samples of drinking-water, have been analyzed during the past year, twelve being from springs, sixteen from wells and eight from river, brook, reservoir, etc. Several samples from the same supply were sent in three cases, because the first samples were contaminated by careless or imperfect sampling. Discarding samples known to misrepresent the supplies on this account we find: Spring waters, eleven supplies, all pure. Well waters, fourteen supplies, six impure, (43 per cent.) River, brook and reservoir waters, eight samples, representing three supplies, two impure, (66 per cent.)

Analyses of sixty samples last year showed 12 per cent spring water, 53 per cent well water and 71 per cent of pond and aqueduct waters impure.

Great care should be used in taking water samples. A new gallon maple syrup can carefully rinsed out with boiling water, then many times with water from the supply which is to be tested makes the most satisfactory package.

The results of water analysis are best interpreted in connection with a survey of the surroundings of the supply. Chemical data which would pass one supply would condemn another from a less favorable situation. Although no hard

and fast rule can be applied, generally speaking, inland waters are considered unsafe for use if they contain more than 40 grains per gallon of solids, 3 grains per gallon of chlorin, or more than 0.05 parts per million of free ammonia or 0.15 parts per million of albuminoid ammonia. Samples marked * were considered impure.

Station Number.	Nature.	SOURCE OF SAMPLE.	PARTS PER MILLION.		GRAINS PER GALLON.			
			Free Ammonia.	Albuminoid Ammonia.	Chlorin.	Total Solids.	Fixed Solids.	Volatile Solids.
2044	SPRING.	Dr. M. D. Smith, Middlebury	0.005	0.11	0.2	6.7	6.	0.7
2046		C. E. Flanders, Proctorsville	0.04	0.06	0.2	2.8	2.2	0.6
2048		E. A. Thompson, Bartonville	0.025	0.12	0.2	5.5	3.6	1.9
2049		R. Child, Moretown	0.00	0.09	0.1	3.8	3.4	0.4
*2050		M. H. Deming, Arlington	0.135	0.075	0.2	7.5	7.1	0.4
2052		M. H. Deming, Arlington	0.00	0.05	0.2	6.5	6.2	0.3
2051		E. L. Wyman, Manchester	0.035	0.115	0.1	6.1	5.6	0.5
2054		Geo. T. Kellogg, East Dorset	0.00	0.02	0.25	10.3	10.1	0.2
2969		J. H. Bates, Proctorsville	0.03	0.05	0.25	2.	1.9	0.1
2068		J. H. Hill, Johnson	0.00	0.01	0.25	7.	6.2	0.8
2072		Dr. M. D. Smith, Middlebury	0.03	0.085	1.15	37.5	32.0	5.5
2074		S. Chandler, Barre	0.03	0.095	0.3	2.8	1.8	1.
*2041	WELL.	Geo. H. Claflin, St. Albans	0.075	0.04	0.25	14.	11.9	2.1
2045		Dr. M. D. Smith, Miedlebury	0.00	0.09	13.1	69.4	....	....
2047		J. R. Richardson, Chester	0.035	0.095	0.7	8.1	6.9	1.2
*2053		R. E. Sampson, Grand Isle	0.96	0.31	2.4	29.2	28.2	1.
2055		O. P. Fullam, Bellows Falls	0.00	0.035	0.05	5.5	4.6	0.9
2060		R. E. Sampson, Grand Isle	0.04	0.05	0.3	17.5	13.1	4.4
*2061		“ “	0.075	0.31	....	....	....	....
*2062		“ “	0.03	0.305	0.2	....	....	....
*2066		Geo. F. Morse, Enosburgh Falls	0.11	0.085	0.75	8.7	7.8	0.9
*2067		J. R. Hill, Johnson	0.62	0.11	1.1	13.7	12.7	1.
2070		J. H. Bates, Proctorsville	0.04	0.085	0.65	9.	7.9	1.1
*2071		“ “	0.09	0.05	0.2	4.8	4.3	0.5
2073		Dr. C. F. Harwood, Dorset	0.03	0.05	0.3	13.3	13.	0.3
2075		F. H. Crandall, Burlington	0.05	0.05	0.3	9.	8.8	0.2
2076		Dr. E. W. Peck, Brandon	0.04	0.04	0.3	25.9	23.5	2.4
*2077		Rev. I. P. Chase, St. Johnsbury Center	0.07	0.175	2.95	37.8	32.9	4.9
2043	RESERVOIR AND BROOK.	Dr. M. D. Smith, Middlebury	0.005	0.038	0.55	25.8	21.8	4.
*2056		Wm. Batchelder, White River Junction	0.275	0.12	0.2	1.4	1.2	0.2
*2057		“ “ “	0.415	0.34	0.2	0.8	0.7	0.1
*2058		Frank Collins, “ “	0.08	0.145	0.2	4.3	4.0	0.
*2059		Wm. Batchelder, “ “	0.065	0.15	0.2	3.3	2.0	1.3
*2063		“ “ “	0.085	0.18	0.2	3.7	2.7	1.0
*2065		“ “ “	0.09	0.18	0.3	3.1	2.0	1.1
*2064		D. H. Moore, “ “	0.96	0.80	0.45	4.4	3.5	0.9
2078		L. H. Lefman, “ “	0.04	0.135	0.6	5.6	3.9	1.7

Pig Feeding.

By J. L. Hills.

The experiments in pig feeding made in 1894 were in continuation of those of previous years, corn meal, bran and the by-products of butter dairying being used as feeds. They were planned to answer the following questions :

1. Is it more profitable to feed skim milk in quantity or to feed less skim milk and make up the difference with grain; or, in other words, do diluted or concentrated rations pay best?

2. What effect have watery and concentrated rations upon the shrinkage in dressing?

3. What are the relative feeding values of skim milk and butter milk?

4. (Incidentally) How do the Poland China, Berkshire and Yorkshire breeds compare in matter of profit?

The results obtained in answer to these questions were :

1. In this experiment the cost of food for a pound of increase in live weight, and the profits were slightly in favor of the less watery ration.

2. The shrinkages were identical by both methods of feeding.

3. In this experiment the buttermilk had about four-fifths the feeding value of skim milk.

4. In one test the Poland Chinas and Berkshires gave the same results ; in another, Berkshires outstripped the Yorkshires.

HISTORY.

The pigs used in these experiments were ten in number.

Nos. 1 and 4 were Poland Chinas bought of A. Niles of East Alburgh. Nos. 2, 5, 8 and 10 were Berkshires and 3, 6, 7 and 9 were Yorkshires, bought of L. S. Drew of South Burlington.

They were about four weeks old when the experiment began, June 1, and the feeding continued until dates ranging from Nov. 15 to 28. For about three weeks previous to June 1, they were fed alike with such amounts of skim milk as they would take. During this time they became used to their quarters, and in fairly uniform condition, although Nos. 4, 5 and 6, which were pitted against Nos. 1, 2 and 3, were the lighter weight pigs from the outset and correspondingly handicapped. The skim milk used was partly from deep cold setting and partly from the separator. The former was warmed before it was fed.

The experiments were two in number and designed to test.

(1) Whether better results are obtained by feeding watery food in comparatively large quantities early in life, or by feeding smaller quantities of the by products and making up the balance of the food with grain ; or, in other words, is it better to feed watery or concentrated food?

(2) Are skim milk or buttermilk of the same feeding value?

The pigs were divided into sets of six and four. No. 1, (Poland China) No. 2, (Berkshire) and No. 3 (Yorkshire) were fed the more concentrated ration, while No. 4, (Poland China) No. 5, (Berkshire) and No. 6, (Yorkshire) were fed the watery ration. No. 7, (Yorkshire) and No. 8, (Berkshire) were fed skim milk, corn and bran, No. 9, (Yorkshire) and No. 10, (Berkshire) buttermilk, corn and bran. Owing to errors in the feeding records of Nos. 3 and 6, which render a portion of them of doubtful value, these two pigs are not included in the summary.

Nos. 1 *and* 2, (*Concentrated food*) were fed two ounces corn meal to a quart of skim milk for about three weeks, then were given what more they wanted in shape of half corn meal and half bran, increasing this from time to time, until they weighed 200 pounds when they were "finished off" with the same amount of skim milk and all the corn meal they would eat. Nutritive ratios varied from 1:2.6 to 1:5.0.

Nos. 4 *and* 5, (*Watery food*) were fed nothing but skim milk until able to take 9 quarts daily; then corn meal was added in proportion of an ounce to the quart, until twelve quarts and twelve ounces were taken. This amount of meal was doubled when the pig could take it and then shortly afterward half bran and corn was added in increasing quantities. Finally the "finishing off" began Nov. 8. Nutritive ratios varied from 1:1.7 to 1:3.0.

It was not intended that Nos. 4 and 5 should be kept on twelve quarts skim milk and twelve ounces of meal as long as they were.

Nos. 7 *and* 8 were fed in the same way general way as Nos. 1 and 2.

Nos. 9 *and* 10 were also thus fed except that seven quarts of buttermilk was fed instead of six quarts of skim milk.

I. DAILY RATIONS OF PIGS.

	Date.	Pigs 1 and 2.				Pigs 4 and 5.			
		Skim Milk. qts.	Corn Meal. oz.	Bran and Corn. oz.	Nutritive Ratio.	Skim Milk. qts.	Corn Meal. oz.	Bran and Corn. oz.	Nutritive Ratio.
I	June 1-20	6	12	..	1:2.6	6	..	..	1:1.7
II	June 21-July 26	6	12	20		9	9	..	
	July 27-August 6	6	12	30	1:3.6	9	9	..	1:2.2
	Aug. 7-15	6	12	36		9	9	..	
III	August 16-September 18	6	12	1 48, 2 42	1:3.9	12	12	..	1:2.3
	September 19-24	6	12	48		12	12	..	
	September 25-October 2	6	12	54		12	24	..	
IV	October 3-16	6	12	84		12	24	..	
	October 17-26	6	12	84		12	24	24	
	October 27-31	6	68	..	1:5.0	12	24	24	1:3.0
	November 1-4	6	90	..		12	24	36	
	November 5-7	6	96	..		12	24	48	
	November 8-14	6	96	..		12	48	..	

I. DAILY RATIONS OF PIGS.

	Date.	Pigs 7 and 8. Skim Milk. qts.	Corn Meal. oz.	Bran and Corn. oz.	Nutritive Ratio.	Pigs 9 and 10. Butter Milk. qts.	Corn Meal. oz.	Bran and Corn. oz.	Nutritive Ratio.
I	June 1-30	6	12	..	1:2.6	7	12	*	1:2.6
II	July 1-26	6	12	12		7	12	12	
	July 27-August 6	6	12	18	1:3.3	7	12	18	1:3.3
	August 7-15	6	12	24		7	12	24	
III	August 16-September 15	6	12	30		7	12	30	
	September 16-24	6	12	36	1:3.7	7	12	36	1:3.7
	September 25-October 5	6	12	48		7	12	48	
IV	October 6-26	6	12	72†		7	12	72	
	October 27-November 14	6	**7** 60 **8** 80	..	1:4.6	7	80	..	1:4.6

*June 22-30, No. 10, received in addition 12 oz. bran and corn daily.
†Oct. 17-26, No. 7, received but 48 oz. bran and corn daily.
NOTE.—Black figures refer to pig numbers.

II. GAIN IN LIVE WEIGHT BY PERIODS.

		Length of Period in Days.	Pig No. 1. Beginning of Period. lbs.	End of Period. lbs.	Gain During Period. lbs.	Pig. No. 2. Beginning of Period. lbs.	End of Period. lbs.	Gain During Period. lbs.	Pig No. 4. Beginning of Period. lbs.	End of Period. lbs.	Gain During Period. lbs.	Pig No. 5. Beginning of Period. lbs.	End of Period. lbs.	Gain During Period. lbs.
I	June 1-20	20	41	62	21	37	60	23	35	54	19	29	46	17
II	June 21-August 15	56	62	126	64	60	128	68	54	103	49	46	96	50
III	August 16-October 2	48	126	185	59	128	185	57	103	157	54	96	149	53
IV	October 3-November 15	44	185	257	72	185	250	65	157	216	59	149	209	60
			Pig No. 7.			Pig No. 8.			Pig No. 9.			Pig No. 10.		
I	June 1-3	30	27	57	30	32	62	30	26	49	23	27	52	25
II	July 1-August 15	46	57	105	48	62	111	49	49	100	51	52	106	54
III	August 16-October 5	51	105	162	57	111	162	51	100	163	63	106	165	59
IV	October 6-November 15	41	162	209	47	162	240	78	163	221	58	165	238	73

III. LIVE AND DRESSED WEIGHTS.

Pig Number	1	2	4	5	7	8	9	10
Live Weight	257	250	232	242	223	240	259	238
Dressed Weight	215	210	196	200	190	198	220	196
Shrinkage in Dressing	42	40	36	42	33	42	39	42
Percentage of Shrinkage	16	16	15½	16½	15	17½	15	17½

IV. TOTAL FOOD EATEN, DRY MATTER EATEN TO ONE POUND GAIN AND FINANCIAL RESULTS.

Number of Pig.	Breed.	Food.	Skim Milk. qts.	Butter Milk. qts.	Corn Meal. lbs.	Bran and Corn. lbs.	Total Dry Matter Eaten. lbs.	Gain in Live Weight. lbs.	Dry Matter Eaten for 1 lb. Gain in Live Weight. lbs.	Gain in Dressed Weight. lbs.	Dry Matter Eaten for 1 lb. Gain in Dressed Weight. lbs.	*Cost of Food Eaten for 1 lb increased in Dressed Weight cts.	†Gain per Pound Dressed Weight. cts.	Profit per Pig.
1	Poland China.	Concentrated.	1008	....	221	359	705	216	3.26	181	3.90	4.86	2.14	$ 3.87
2	Berkshire.	Concentrated.	1008	....	221	347	695	213	3.27	179	3.88	4.85	2.15	3.75
4	Poland China.	Watery.	1724	....	152	41	518	181	2.87	153	3.39	4.80	2.20	3.37
5	Berkshire.	Watery.	1724	....	152	41	518	180	2.88	149	3.48	4.80	2.20	3.28
7	Yorkshire.	Skimmilk.	1008	....	186	234	563	183	3.07	156	3.61	4.61	2.39	3.73
8	Berkshire.	Skimmilk.	1008	....	211	249	601	208	2.89	172	3.50	4.46	2.54	4.37
9	Yorkshire.	Buttermilk.	....	1176	211	249	625	195	3.19	166	3.76	4.63	2.37	3.93
10	Berkshire.	Buttermilk.	....	1176	211	256	631	211	2.98	174	3.62	4.45	2.55	4.44

*Corn Meal, $20 per ton; Bran, $18 per ton; Skim Milk, 15 cents per 100 lbs; Butter Milk, 13 cents per 100 lbs.
†Pork sold at 7 cents per pound dressed weight.

CONCENTRATED AND WATERY FOODS.

Since Nos. 1, 2, 7 and 8 were fed essentially alike on relatively concentrated food, (although the two latter were in another experiment) the four results may be used to compare with those obtained with the more watery fed Nos. 4 and 5. The salient points of the tables on the preceeding pages for the average pig of each set are as follows :

	Period.	Concentrated.	Watery.
GAIN IN LIVE WEIGHT PER DAY IN POUNDS.	I	1.05	0.90
	II	1.12	1.08
	III	1.14	1.11
	IV	1.58	1.38
Average live weight Nov. 15.................		239	213
*Average Dressed weight Nov. 15............		199	178
Per cent shrinkage		16½	16½
Dry matter eaten per pound of gain in live weight (to Nov. 15)........................		3.12	2.87
Dry matter eaten per pound of gain in dressed weight (Nov. 15)....................		3.72	3.44
Cost of food per pound increase in dressed weight		4.70	4.80
Total gain per pig (dressed pork at seven cents)		$3.93	$3.33

* Pigs 4, 5 and 7 lived a few weeks after Nov. 15. It is assumed that there would have been the same per cent. shrinkage if killed then that was found later. The error thus introduced, if any, is slight.

It appears that the main difference in results is simply that the pigs fed the larger amount of skim milk, but the less actual nutriment, gained less and made less profit than their mates. They shrank as little, however, and made as good use of the food given them as did those fed dryer rations. In this experiment the balance is slightly in favor of the more concentrated food since the cost of the food per pound of increase in dressed weight is less and gross profits more with the concentrated than with the watery foods.

SKIMMILK VS. BUTTERMILK.

We can again use the data of Nos. 1, 2, 7 and 8 as one in comparing the relative feeding values of skimmilk and buttermilk. The same general results are obtained when Nos. 7 and 8 are used alone.

	Period.	Skim Milk.	Butter-milk.
GAIN IN LIVE WEIGHT PER DAY IN POUNDS.	I	1.05	0.80
	II	1.12	1.14
	III	1.14	1.20
	IV	1.58	1.64
Average live weight at Nov. 15		239	230
Average dressed weight		199	192
Per cent shrinkage		16½	16½
Dry matter eaten per pound of gain in live weight		3.12	3.08
Dry matter eaten per pound of gain in dressed weight		3.72	3.69
Cost of food per pound increase in dressed weight		4.70	4.54
Total gain per pig (dressed pork at seven cents per pound)		$3.93	$4.14

The pigs fed on buttermilk gained a little faster, shrank the same, and ate the same to make a pound of gain. The cost of food per pound increase in dressed pork and profit per pig is somewhat in favor of the buttermilk if it is rated at 13 cents and skim milk 15 cents per hundred pounds. If the former is estimated at four-fifths the value of skim milk (the proportion found in experiment reported in the Fourth Report, pp. 22-24, Wisconsin Experiment Station) the total gain per pig from each is practically the same.

COMPARISON OF BREEDS.

We have the data at hand for a comparison of the three breeds—Poland China, Yorkshire and Berkshire. The summarized account is as follows, calculated for the average of two pigs in each case:

		Nos. 1-4. Poland China.	Nos. 2-5. Berkshire.	Nos. 7-9. Yorkshire.	Nos. 8-10 Berkshire.
GAIN IN LIVE WEIGHT PER DAY IN POUNDS.	I	1.00	1.00	0.88	0.92
	II	1.01	1.05	1.08	1.12
	III	1.18	1.15	1.17	1.08
	IV	1.52	1.45	1.20	1.76
Average live weight at slaughter.		237	230	215	239
Average dressed weight.........		199	196	183	197
Per cent shrinkage		16	16½	15	17½
Dry matter eaten per pound of gain in live weight........		3.07	3.08	3.13	2.94
Dry matter eaten per pound of gain in dressed weight......		3.65	3.68	3.69	3.56
Cost of food per pound increase in dressed weight..........		4.83	4.83	4.62	4.46
Total gain per pig (dressed pork at seven cents per pound)...		$3.62	$3.52	$3.83	$4.41

The Poland Chinas and Berkshires in the same experiment gave very uniform results. The Berkshires outstripped the Yorkshires in the second test.

PROPER TIME TO MARKET PORK.

It is well known that a maturing animal needs increasing proportions of its food to support life, and that a smaller percentage of the total food is left for inducing growth. There comes a time then when it costs more to keep a pig alive than the gain is worth, a point depending mainly on the selling price of pork. A study of the net gain per pound by periods will be instructive in this connection:

Period.	Average weight at end of each year. lbs.	Average cost of food consumed for each pound of live weight. cents.	Average selling price per pound live weight. cents.	Average gain per pound increase in live weight. cents.	Total gain during period.
I	55	2.65	5.88	3.23	$ 6.07
II	109	3.47	5.88	2 41	10.41
III	166	4.23	5.88	1.65	7.47
IV	230	4.56	5.88	1.32	6.76

These pigs were marketed quite young in spite of a high price for pork, and paid well throughout their lives, although the margin of profit was decreasing rapidly. Some of the pigs were kept beyond Nov. 15, No. 4 gained 16 pounds in 13 days; No. 5, 33 pounds in the same time; No. 7, 14 pounds in the same time; No. 9 weighed but 9 pounds more Dec. 31 than on Nov. 25. It is doubtful if three of these four much more than paid their way at the end.

FINANCIAL SUMMARY.

The pigs more than paid their way. They increased in live weight (up to November 15) 1,586 pounds which sold for $93.26, while the food which they ate cost $62.50, a profit of $29.7 , with corn meal at $20 a ton, bran $18 a ton, skim milk at 15 and buttermilk at 13 cents per hundred pounds. If the price of the pigs is brought into the problem the calculation would be as follows:

1,542 pounds of dressed pork at 7 cents		$107.94
Cost of pigs	$22.00	
Food for pigs	62.50	—84.50
Profit		$23.44

This latter method of figuring applies only when pigs are bought each year, the former method applies better when the pigs are home grown.

VALUE OF SKIM MILK.

It has been hitherto assumed in writing up pig feeding experiments at this station that skim milk was worth 15 cents a hundred pounds. We have always found it to have a greater feeding value than this, yet it may be bought at most creameries for less than 15 cents. Since the utilization of dairy by-products is a main purpose in pig feeding in Vermont, it is fair to subtract the cost of grain fed from the total profits, allowing the manure to offset the care, and call the difference the value of the skim milk and buttermilk.

1,586 pounds increase in live weight	$93.26
1,565 corn meal and 1,776 pounds corn and bran	32.52
Value of 20,647 pounds skim milk and buttermilk or 29 cents per hundred pounds	$60.74

FERTILIZING VALUE OF FEED.

This is a matter which should be kept in mind, since all these foods are rich in plant food. Skim milk and butter milk are worth 11 and 10 cents per hundred respectively, corn meal, 30, and bran, 66 cents per hundred as fertilizers. If the manure is properly handled much of this may be saved after having served as food.

The total fertilizing value of the food eaten is $38.93 from food costing $62.50, the fertilizing value thus representing 62 per cent of the market value of the food.

Report of the Botanist.

L. R. Jones.

The results of the botanical investigations of the year are grouped under the following heads:

I. Experiments in Spraying Potatoes.
   1. Plan of the Experimental Plots.
   2. Potato Troubles as they Occurred in 1894.
   3. The amount of Gains from Spraying Potatoes in 1894.
   4. The Comparative Values of various Fungicides Tested.

II. Observations upon the Date of Planting Potatoes.

III. Experiments in the Prevention of Potato Scab.

IV. Experiments in the Prevention of Apple and Pear Scab.

V. The Occurrence of Oat Smut in 1894.

VI. Observations upon Grasses and Weeds.

VII. Some Studies upon Carnation Rust.

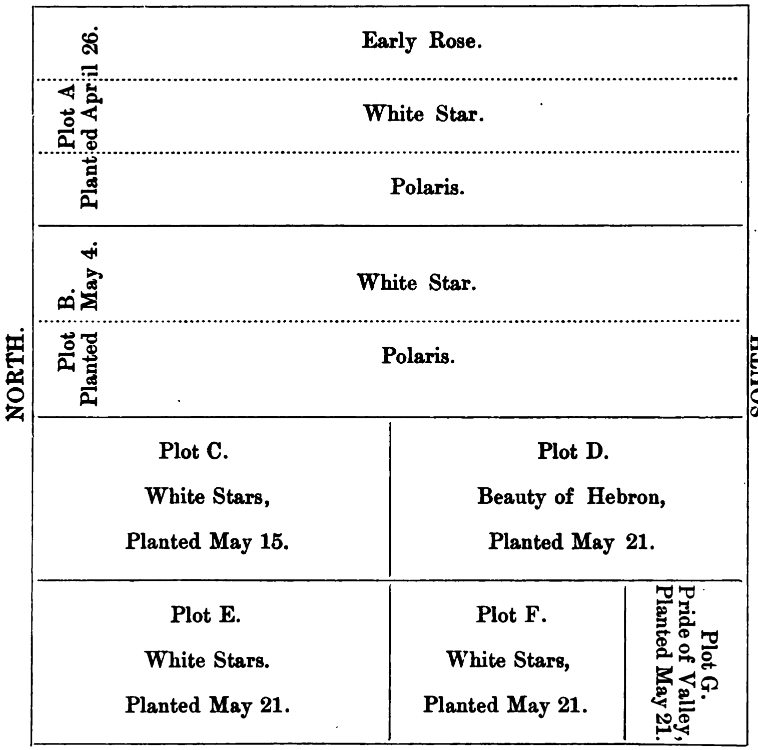
I. EXPERIMENTS IN SPRAYING POTATOES.

1. PLAN OF THE EXPERIMENTAL PLOTS.

Considerable attention was given again this year to the study of the various diseased conditions of the potato, and remedies for the same.

The experimental field planted with potatoes contained about one acre. It was somewhat irregular in shape, owing to the oblique direction of the road lying along one side of it. Without trying to figure minor irregularities, the following general plan of the plots is given.

GENERAL PLAN OF POTATO PLOTS SPRAYED EXPERIMENTALLY IN 1894.



In addition to this field there were excellent opportunities to study certain problems in neighboring potato fields where the conditions were different. The soil was a rather heavy clay loam. The land had been in grass for a dozen or more years previous. This sod was turned the preceding autumn, and the entire field except plot *B*, given a dressing of stable manure during the winter and early spring. A little commercial fertilizer was applied in the hill at time of planting. All planting was done in hills, to facilitate experimental work, since the rows thus running both ways favored the laying out of sub-plots for spraying. In all spraying experiments every third row was left unsprayed to serve as a check. It is believed that the errors arising from slight inequalities of the soil were thus satisfactorily corrected in most cases. The yields from these plots under the vairous experimental conditions are given in tabular form on pages 102–104.

2. POTATO TROUBLES AS THEY OCCURRED IN 1894.

In former spraying experiments upon potatoes at this Station, extending over five years, the main disease under consideration has been the late blight and the attendant rot (*Phytophthora infestans*). A secondary disease, quite important in some cases, has been the early blight caused largely by the fungus *Macrosporium Solanti*. Certain other troubles have been intimately associated with this last disease, notably the injuries of the flea-beetle. During the past season (1894) the prolonged drought of midsummer quite reversed the order of importance of these agencies. The Station plots remained practically free from the *Macrosporium* fungus.* Careful watch was kept for *Phytophthora*, but no evidence of its work was detected upon the tops. At digging time and during the winter a sufficient number of tubers showed the dry rot to prove that the fungus was present, and did a certain amount of damage, especially on plots E, F and G. Aside from this, however, the only apparent troubles upon the field were due to insects and to lack of water. The chief gains from spraying upon most of the plots were therefore attributable in our judgment, to the effects of the substances used upon the insects rather than upon the fungi. It is generally admitted that Bordeaux mixture has some unexplained beneficial effect upon plants in addition to its action toward either parasitic fungi or insects. In interpreting the results obtained some allowance must doubtless be made for this unknown factor. Even casual visitors to the fields, however, were convinced of the direct and important value of the Bordeaux mixture in checking work the of insects. Chief among these insect pests was the cucumber flea-beetle (*Crepidodera cucumeris*). We described and figured this insect in our last report. So few potato growers have learned to recognize the nature of its injuries that an engraving from a potato leaf is here inserted, showing its work. (Figure 1).

Fig. 1. Potato leaf eaten by Flea-beetles.

Fig. 2. Healthy potato leaf, sprayed with Bordeaux mixture.

The damage done by this beetle in 1893 was considerable, but nothing compared with its work in 1894. Its unusual abundance this year was doubtless attributable to the dry weather. Two clearly marked broods of the

*Although our own fields were entirely free from the Macrosporium there was as well developed a case of this trouble as we have ever seen in a field less than half a mile distant.

beetle were observed. The first brood appeared early in June, and after doing considerable damage disappeared about the middle of the month. The next brood appeared about July 20th in countless numbers and soon riddled the leaves of all unprotected plants. Some observations upon the action of Bordeaux mixture in checking this insect were made in 1893 and noticed in our last report.*

A continuation of this work had been planned for 1894 and systematic observations were at once begun to determine the exact value of the different substances used in repelling the flea-beetle. These examinations showed that there was a marked protective effect from the various forms of Bordeaux mixture and from modified Eau Celeste. The stronger the mixture the more evident this effect became, and soap appeared to add to the value of the mixtures. The rows sprayed with ammoniacal copper carbonate were but slightly protected. Paris green applied either in plaster or in water was not an effective remedy. In order to determine how complete was the protection given by the Bordeaux mixture two leaves were taken from the side† of each hill of a sprayed row and of an adjoining unsprayed row, which had, however, been poisoned with Paris green.

The actual number of holes per leaflet, from the unsprayed row was found upon counting to be 262, while from the sprayed row the average was but twelve. The condition of some of these leaves is strikingly shown in Figures 5 and 6. These results bear out completely the conclusions of last year and justify the claim that the Bordeaux mixture is the best practical remedy known for the flea-beetle as it occurs upon potatoes.

These observations were made on Plots *A* and *B* especially. The flea-beetles, of course, attacked all parts of the field indiscriminately, but upon the later planted plots the plants were still in vigorous growth and so suffered less from the attack of these insects. None of these late plots had as yet been sprayed. Expecting that the blight might soon appear, portions of these late plots were sprayed August 1st.

About this time the last of the hay crop was removed from the adjoining fields. Thereupon the grasshoppers migrated in large numbers from this hay field and settled especially upon these younger potato-plants. Here again as with the flea-beetle, the Paris green did not seem sufficient to check them. Probably this was because they did their most serious damage by eating the stems and the petioles of the leaves where but little poison was present. The appearance of the mutilated plants is shown in Figure 8. Fortunately the Bordeaux mixture seemed equally as offensive to them as it had to the flea-beetles. The result was that before the last of August the contrast between the sprayed and unsprayed rows of these later potatoes was almost as marked as it has been in seasons when the blight has swept over

*Seventh Report Vermont Experiment Station 1893, page 50.

†They were taken about midway between base and top, since the lower (older) leaves had been somewhat eaten by the beetles of the first brood and many of the upper (younger) leaves had developed since the spraying was done.

the field. The grasshoppers had cut off so many leaves that the plants were all dead upon the unsprayed rows, while the adjoining sprayed rows were comparatively thrifty. The appearance of the field on August 31 is shown in Figure 9.

Here again all the difference should not be attributed to the work of the grasshoppers. Some was due to the flea-beetles, some doubtless to unperceived fungus troubles and some to the unexplained beneficial action of Bordeaux mixture. Careful observations in the field from day to day left no doubt in our minds, however, that the greater part of the difference was due to the action of the mixture as a deterrent against the grasshoppers.

The actual damage to the crop by the flea-beetles and the grasshoppers was much aggravated by the dry weather, since the leaves mutilated by the insects soon shriveled and died. The Bordeaux mixture and some of the other fungicides in less degree thus served indirectly to aid the plants considerably in withstanding the drought.

3. THE AMOUNT OF GAINS FROM SPRAYING POTATOES IN 1894.

When the late blight and rot are prevalent the gains from spraying in Vermont are often enormous. In many cases our crop was doubled and even trebled by the application of Bordeaux mixture during 1892 and 1893. No such large gains can be hoped for in a dry season like that of 1894. Indeed, it was hardly expected at midsummer, that the gain would be sufficient to equal the cost of the applications. The development of the insect troubles during July and August, and the slight occurrence of the late blight in September gave the fungicides opportunity to prove their worth, as will be seen from the following summary of the results. These figures are abstracted from the fuller tabular statements of results given at the close of this article.

GAINS FROM SPRAYING POTATOES WITH THE BORDEAUX MIXTURE, 1894.

VARIETY.	Date of Planting.	No of times Sprayed.	Dates of Application.	Yields in Bushels per Acre.		Gain in Bushels.	Gain per ecnt.
				Sprayed.	Not Sprayed.		
White Star.......	April 26	3	June 16	323	251	72	29
Polaris	"	3	July 17	213	190	23	12
Early Rose.......	"	3	Aug. 30	190	146	44	30
White Star.......	May 4	2	July 18	201	166	35	21
Polaris...........	"	2	Aug. 30	164	135	29	21
Beauty of Hebron.	May 15	1	Aug. 1	147	124	23	19
Beauty of Hebron.	May 21	2	Aug. 1-31	168	150	18	12
White Star.......	"	1	Aug. 1	253	198	55	28
Pride of Valley...	"	1	Aug. 1	228	180	48	27

These gains, while not large, much exceed the cost of spraying and fully demonstrate that the use of the Bordeaux mixture upon potatoes is a profitable thing, even in exceptionally dry seasons like the last one.

4. THE COMPARATIVE VALUES OF VARIOUS FUNGICIDES UPON POTATOES.

This work forms a continuation of our experiments along the same lines in previous years. The conditions of weather during 1894 were so peculiar that the results are especially valuable as a supplement to previous experiments in so far as they concern the fungicides tested in seasons when the rainfall was greater. This applies to *a*, *e*, *f* and *g* below. In the case of the tests undertaken now for the first time (especially *b*, *c* and *d*) the results may be quite different in a wetter summer, and positive conclusions from them should be deferred until experiments under such conditions have been made.

The leading points of these experiments were to determine the relative values of :

a. Stronger and weaker Bordeaux mixture.
b. Bordeaux mixture in the form of a dry powder.
c. Bordeaux mixture which has stood some time after preparation.
d. Bordeaux mixture made by the potassium ferrocyanide test.
e. Modified eau celeste.
f. Ammoniacal copper carbonate (Delaware formula).
g. Soap as added to liquid fungicides.

a. *The relative values of the Stronger and the Weaker Bordeaux Mixtures.*

The stronger mixture consisted of one pound of copper sulphate and one pound of lime to five gallons of water. The weaker was exactly one-half this strength. In all cases where a careful comparison could be made the stronger mixture gave a little larger gains than did the weaker; for example in Plot *A* the strong mixture gave a yield of 260 and the weak of 256 bushels per acre. This difference was less marked than it has been in previous years, doubtless owing to the dryer weather of the present summer. The question arises whether the additional gain from the use of the stronger mixture is sufficient to repay the additional cost

If these applications are made using 450 gallons per acre, the cost of the chemicals becomes a matter of some importance. If the stronger mixture is used it requires about ninety pounds each of copper sulphate and lime, costing about $7. If the weaker mixture is used the cost is reduced one-half. The gain from the stronger mixture, noted on Plot *A* would not repay this extra cost. It should be remembered, moreover, that the stronger the mixture, the greater the clogging of the nozzles and the subsequent inconvenience of using the mixture. In general, we believe an intermediate strength would be found most profitable, using about one pound of the copper sulphate to seven and one-half gallons of water, or about six to seven pounds for each barrel of the mixture.

b. *The relative value of Bordeaux mixture applied as a dry powder.*

The inconvenience of preparing the Bordeaux mixture and the expense of pumps with which properly to apply it have been serious obstacles in its introduction into general use. Any device that will successfully obviate these

difficulties will therefore be gladly welcomed. During the past year an attempt has been made to do this by applying the mixture in the form of a very fine dry powder. The firm of Leggett & Brothers, of New York, have sent out such a powder under the name of "Fungiroid," and as this has been advertised extensively in Vermont, a large number of inquiries have been received concerning its value. Careful tests of this Fungiroid were planned, and also of a similar powder prepared by ourselves. In preparing this the mixture was made by the ferrocyanide test. The precipitate was then thoroughly dried and very finely powdered by passing between regular mill stones, We shall speak of this as Bordeaux powder. The powders were applied with Leggett's dry powder gun.

In order to give the powders the best possible chance to adhere, the plants were, in most cases, sprinkled with water just before applying them. On Plot *A* three applications of clear Bordeaux powder were made at same dates as regular sprayings. The powder was applied very freely, using at the rate of fully forty pounds per acre* each application. The yield under this treatment, as shown in Table 1, was 243 bushels per acre, while the adjoining rows sprayed with weak Bordeaux mixture yielded 256 bushels per acre. A portion of the later planted potatoes was staked out as Plot *J*, for a more extended trial of both the Fungiroid and the Bordeaux powder in various degrees of dilution. Unfortunately, different portions of this plot suffered unequally from the drought owing to some differences in the slope of the land. The yields as shown in Tables X and XI are not therefore a very safe source from which to draw conclusions. The general nature of these results, together with the appearance of the growing plants as noted during September make it clear that the dry Bordeaux powder is a fungicide of considerable merit and worthy of further careful trial. At present, however, we do not feel justified in recommending it as a safe substitute for the wet form of the mixture. A comparison of Tables X and XI would indicate that the home-made powder was superior to the Fungiroid, but until there has been opportunity to test them again under more favorable circumstances it is not just to draw decided conclusions.

c. *What is the relative value of Bordeaux mixture which has stood some time after being made.*

Does Bordeaux mixture deteriorate upon standing, and, if so, to what degree? If a quantity of the mixture remains at the close of one spraying, is it advisable to keep it till the next application is to be made and then use it, or should it be thrown away and only the freshly prepared mixture used? These and similar questions are often asked by those using the mixture. As a practical test of the value of the mixture which has stood thus a quantity was prepared in June, and certain rows upon Plot *A* were sprayed with this old mixture during July and August. As will be seen by referring to yields

*The first application was considerably heavier than this; the others approximately this amount

given in Table I., this mixture proved considerably inferior to that freshly prepared as used, the yield where this old mixture was used being 229 bushels per acre as compared with 260 bushels per acre where the freshly prepared mixture was employed. It was planned to continue similar tests upon the potatoes sprayed later, but the prolonged drought defeated these plans and left us with only the results from this one plot upon which to base conclusions.

d. What is the relative value of Bordeaux mixture made by the potassium ferrocyanide test?

Bordeaux mixture, as usually made, contains from two-thirds of a pound to one pound of lime for each pound of copper sulphate. The lime is used to precipitate the copper. It is some trouble to weigh out the lime in making the mixture, and to avoid this the use of the ferrocyanide test has been proposed. This test consists in adding a few drops of a solution of ferrocyanide of potassium to the mixture. If there is not enough lime in the mixture this added solution will at once turn brick red, but if enough lime has been added there will be no change of color. A series of careful trials showed that about one pound of the fresh lime used in these experiments will neutralize three pounds of copper sulphate, as shown by this test. The question at once arises, is this mixture, containing only about one-third the amount of lime as efficacious as the mixture made by the old formula? A comparative test of both the strong and the weak mixtures made by the two methods was made on Plot *A*. In both cases the mixture made with the excess of lime, i. e., by the regular formula, gave the better results. The yields from these tests were as follows:

Strong	Bordeaux	mixture,	regular formula,............260	bushels	per	acre.
"	"	"	ferrocyanide test............241	"	"	"
Weak	"	"	regular formula........ ...256	"	"	"
"	"	"	ferrocyanide test............242	"	"	"

Similar evidence was obtained from some of the later planted potatoes. It seems clear, therefore, that under the conditions which existed last summer, the mixture made by the test was inferior to that containing an excess of lime. If this is the case in a dry summer, we should expect it to be even more so in one when the normal amount of rain falls, since the lime doubtless makes the mixture more adhesive. We advise, therefore, that in preparing the mixture by the ferrocyanide test an excess of lime be added after the mixture ceases to respond to the test, It will be an easy matter to add by guess after the mixture is neutralized approximately as much more lime as has already been used. A mixture can thus be made which possesses the virtues of the old method and still avoid the trouble of weighing the lime.

e. What is the relative value of Modified Eau Celeste?

This fungicide is made by dissolving four pounds of copper sulphate in ten gallons of water, then adding five pounds of sal soda. The precipitate thus

formed is dissolved by the addition of three pints of strong ammonia, and the whole diluted with water to forty-five gallons. A perfectly soluble fungicide is thus prepared which will retain its strength indefinitely if kept sealed. In our experiments with this in former years it has always proved somewhat inferior to the Bordeaux mixture, but was by far the best of the soluble fungicides. The results this year justify the same conclusions. The results from Table I are as follows:

Strong Bordeaux mixture	260 bushels per acre
Weak Bordeaux mixture	256 " " "
Modified Eau Celeste	240 " " "

The modified eau celeste is more expensive than the Bordeaux mixture, and the superior results from the mixture will well repay the additional trouble of making and applying it. We used double strength modified eau celeste upon one row of potatoes, and applied it freely with a watering pot. The foliage showed no signs of injury from this unusual application.

f. What is the relative value of Ammoniacal Copper Carbonate?

This is the most convenient fungicide ever tried at this Station. In comparative tests of it made during 1892 and 1893, it proved disappointingly worthless, however. The method then used in its preparation was to dissolve five ounces of copper carbonate in three pints of strong ammonia and dilute to forty-five gallons. Bulletin 22, of the Delaware Station, which appeared early in 1894, recommended a new method of preparing this fungicide by which its strength could be increased. This method differed from the old one in diluting the ammonia with from seven to eight volumes of water before adding the copper carbonate. In the hope that this method might so improve the fungicide as to make it of practical value in spraying potatoes it was added to the list for trial again in the experiments of 1894. The results as shown by the yield in Table I give no further encouragement, however. The yields were as follows:

Weak Bordeaux mixture	256 bushels per acre
Ammoniacal Copper Carbonate	163 " " "
Check row (untreated)	162 " " "

The appearance of the plants during the summer agreed substantially with the above figures, and we feel satisfied that this fungicide is so nearly valueless as to be unworthy of further trial on potatoes.

g. What is the value of soap when added to Fungicides?

Trials of soap added to Bordeaux mixture and other fungicides in 1893 led to the conclusion that its value was at least doubtful. Further trials along the same line were made in 1894. The results as shown in Table I are entirely against it when used with the stronger fungicides. These results following upon those of 1893 fully warrant the conclusion that the soap on the whole is more liable to detract from the value of the fungicides than to add to it. The expense and inconvenience attending its use are, moreover, considerable. It is not considered worthy, therefore, of further trial upon potatoes.

TABLES SHOWING RESULTS OF SPRAYING POTATOES WITH VARIOUS FUNGICIDES DURING 1894.

TABLE I.—Plot A, White Star, Polaris and Early Rose potatoes, planted April 26. Applications made on June 30th, July 18th and August 30th, unless otherwise stated.

TREATMENT.	YIELDS.
1. Strong Bord. Mixt., applied July 18 and August 30..	246 bushels per acre
2. Gypsum dusted on leaves	199 " "
3. Strong Bordeaux Mixture	260 " "
4. No fungicide	206 " "
5. Strong Bordeaux Mixture with Ferrocyanide test..	241 " "
6. Strong Bord. Mixt., allowed to stand after made ..	229 " "
7. No fungicide	174 " "
8. Strong Bord. Mixt., Ferrocyanide test with soap	253 " "
9. Weak Bordeaux Mixture, Ferrocyanide test	242 " "
10. No fungicide	194 " "
11. Weak Bordeaux Mixture	256 " "
12. Bordeaux Powder, (heavy application)	243 " "
13. No Fungicide	196 " "
14. Modified Eau Celeste	240 " "
15. Modified Eau Celeste with soap	213 " "
17. No fungicide	162 " "
18. Ammonical copper carbonate (Delaware formula)..	163 " "
19. Ammonical copper carbonate with soap	203 " "
20. No fungicide	187 " "

TABLE II.—Plot B, White Star and Polaris potatoes, planted May 4th. Two applications made, July 18 and August 31.

TREATMENT.	YIELD.
1. Average yield of all rows not sprayed	147 bushels per acre
2. Strong Bordeaux Mixture with soap	201 " "
3. Weak Bordeaux Mixture	186 " "
4. Weak Bordeaux Mixture, Ferrocyanide test	158 " "

TABLE III.—Another portion of same piece as plot B, sprayed only once, August 1.

TREATMENT.	YIELD.
1. Average of all rows not sprayed	135 bushels per acre
2. Weak Bordeaux Mixture	155 " "

TABLE IV.—Plot C, Beauty of Hebron potatoes, planted May 15th. Sprayed only once, August 1.

TREATMENT.	YIELD.
1. Average of rows not sprayed	123¼ bushels per acre
2. Weak Bordeaux Mixture	147 " "

TABLE V.—Plot D, Beauty of Hebron potatoes, planted May 21, north end, sprayed twice, July 6th and August 1st.

TREATMENT.	YIELD.
1. Average of rows not sprayed	146 bushels per acre
2. Sprayed with weak Bordeaux Mixture	161½ " "

TABLE VI.—Plot D, south end sprayed twice, August 1st and 20th.

TREATMENT.	YIELD.
1. Average of rows not sprayed	155 bushels per acre
2. Sprayed with weak Bordeaux Mixture	174 " "

TABLE VII.—Plot E, White Star potatoes, planted May 21, sprayed once, August 1st.

TREATMENT.	YIELD.
1. Average of rows not sprayed	198 bushels per acre
2. Sprayed with weak Bordeaux Mixture	253 " "

TABLE VIII.—Plot G, Pride of the Valley potatoes, planted May 21, sprayed once, August 1st.

TREATMENT.	YIELD.
1. Average of rows not sprayed....	180 bushels per acre
2. Sprayed with weak Bordeaux Mixture........... ...	228 " "

TABLE X.—Plot F, White Star potatoes, planted May 21, one application made August 6th. (Soil not very uniform, hence these results are not altogether reliable.)

TREATMENT.	YIELD.
1. Weak Bordeaux Mixture....	169 bushels per acre
2. Leggett's fungiroid, heavy application..............	167 " "
3. Ditto, mixed with equal parts of flour...............	153 " "
4. Ditto, 2¼ oz. water, 1 gallon...............	140 " "
5. Ditto, mixed with 5 parts flour.....	118 " "
6. Check rows, no fungicide........................	112½ " "

TABLE XI.—White Star Potatoes, planted May 21. One application made August 6th. (Soil not very uniform.)

TREATMENT.	YIELD.
1. Home made "Bordeaux Powder," heavy application.	223½ bushels per acre
2. Bordeaux Powder with equal parts flour............	207 " "
3. Bordeaux Powder with five parts flour.............	207 " "
4. Bordeaux Powder, 2¼ oz. in water, 1 gal....... ...	204 " "
5. Weak Bordeaux Mixture.........................	200 " "
6. Check rows, no fungicide........................	163½ " "

II. OBSERVATIONS UPON THE DATE OF PLANTING POTATOES.

Any practical study of the diseases of the potato in Vermont must include a consideration of the date of planting, and consequently of the maturity of crop. As a result of observations and experiments extending through the years of 1890–93, the conclusion was published in our last Report that when one is working merely for the largest crop with the least possible work in protecting it from insects and diseases, he will do best to use a vigorous variety of medium or late potatoes, and delay the planting until about May

10th to 20th. The reason for this is obvious when the usual conditions of rainfall in Vermont are considered. Potatoes planted in the last of April will form their tubers during the period extending from the last of June to the first of August, the exact time varying with the variety, that is, whether it is an early or late one. Now, potato tubers contain about eighty per cent water, the remainder is starch, and in the manufacture of this starch a large additional amount of water is consumed. During the period of tuber formation the potato plant therefore needs its largest supply of water. As a matter of fact, however, the period from the last of June to the first of August is usually the driest portion of our summer. By planting potatoes the last of April, therefore, we force them to form tubers when the water supply is least, and as a result we rarely get a full crop. In fact, if there are serious attacks of insects or of fungus diseases during this period, the earlier planted potatoes die or "ripen prematurely," giving a small yield of imperfectly ripened potatoes. The only compensation is that these early potatoes, dying thus in the dry weather, largely escape danger from the late blight and rot. Before a remedy for this disease was known most successful potato growers preferred to plant early and thus be sure of the smaller yield, rather than to plant later and run the risk of serious loss from the blight and rot. By the use of Bordeaux mixture later potatoes may now be perfectly protected against disease during the warm, most weather of August and early September. By planting May 10th to 20th. the later varieties form their tubers during this period, which is usually the most favorable of all the summer, and as a result very large yields become possible. For example, in 1893, Polaris potatoes planted April 29, under the best treatment of spraying, etc., yielded 295 bushels per acre; while Polaris potatoes taken from the same bin and planted May 9, with the same treatment, yielded 378 bushels per acre. White Stars, planted May 20, yielded 400 bushels per acre. The conclusion, therefore, based on the experiments of 1890-93, was that the later planting is the most profitable. In 1894, however, results were exactly reversed. Our plantings of the same varieties extended from April 29 to May 23. The largest yields came from the earliest planted, the smallest yields from the latest, other conditions being equal. Thus White Star potatoes planted April 26th, yielded 323 bushels per acre, while the same variety planted May 21st gave only 253 bushels. Looking for the reasons, they are easily found. To begin with, the first week of May was the warmest of the month. The early planted potatoes got rooted and started under favorable conditions. About May 20 cold, wet weather set in and lasted for two weeks. The later planted potatoes lay in the ground without starting during this time, and many of them rotted before or immediately after sprouting. Immediately following this in June a protracted drought began which continued into September with but slight and infrequent rainfalls. Of course, the late planted potatoes, starting under unfavorable conditions, never fully recovered, and they made a poor growth throughout the summer. When

the attacks of the flea-beetles and grasshoppers came in July and August the plants which were mutilated by them very generally succumbed to the combination of insect attacks and dry weather. The early planted potatoes made sufficient growth in early summer to more fully shade the ground and developed sufficient root system to carry them more successfully through these disastrous conditions into September, when the welcome rains came. Where they were protected by Bordeaux mixture the majority of them lived until late fall. There was no hard frost in Burlington until November, and some of the more vigorous plants still held a good portion of their leaves green until this date. Polaris potatoes, planted April 27, lived past the middle of October, nearly six months from planting till death, and White Stars planted on the same date lived into November, or over six months from date of planting. This is a remarkable record for potato plants in Vermont. Usually these same varieties of potatoes when planted in April have died in August or by September first. Apparently, the peculiar weather conditions of May to July retarded their maturity and induced such a gradual formation of tubers that they persisted longer than usual. Probably, also, the entire absence of the early blight from the field during the summer conduced to the same result. To conclude, then, the date of planting should depend upon whether one is prepared to spray, and also upon the conditions of weather which are to be expected. In our judgment, the season of 1894 was such an exceptional one that the results should not lead to any modifications of our former advice, and that for the largest yield in Vermont medium or late planting, combined with spraying, should be practiced.

III. EXPERIMENTS IN THE PREVENTION OF POTATO SCAB.

Potato scab ranks second only to the late blight as an enemy to the highest success in potato culture in Vermont. The primary cause of the scabbing of potatoes in this section of the country is a fungus growth. This fungus is propagated by means of spores. The details of this matter have been discussed in former publications and it is only necessary to recall here that the two chief sources of danger to the crop are from the presence of these spores either upon the seed that is to be used or in the soil before the seed is planted. Certain western investigators, notably Professor Bolley of the North Dakota Experiment Station, have been successful in preventing the scab upon potatoes by disinfecting the seed potatoes before planting with a solution of corrosive sublimate.*

*Following are practical directions for so disinfecting them: Purchase from a druggist two ounces of corrosive sublimate (bichloride of mercury.) Empty this into two gallons of hot water in a wooden or earthen vessel, and allow it to stand over night. Place in a barrel, or wooden tub, thirteen gallons of water, then pour in the two gallon solution. Stir thoroughly to insure equality of solution before using. Select as fair seed potatoes as possible, rinse off the old dirt and immerse them in the solution one hour and thirty minutes. At the end of this time turn off the solution into another vessel. The solution may thus be used a number of times if wished. After drying, the potatoes may be cut and planted as usual. Corrosive sublimate is an active poison and should be handled with care. The solution here recommended is dangerous only if taken into the stomach. Potatoes treated and unused should be destroyed.

There can be no doubt that under the conditions of the experiments of these investigators the practical value of this method of disinfecting seed potatoes has been thoroughly demonstrated. They have proved that when seed is thus treated a clean crop is insured, *providing* the soil is clean also. Unfortunately much of the best potato land in Vermont appears already to be contaminated with the germs of this scab fungus. The demonstration of the exact practical value of this corrosive sublimate treatment as applied to our conditions is yet largely to be made. As a contribution to this end a series of plots were laid out in a portion of the potato field in 1894. The land used had been in grass for at least fifteen years previous, and commercial fertilizers alone were used upon it. The plots lay as follows:

1. Polaris, Scabby. No treatment.	5. Polaris, Smooth. No treatment.	9. Polaris, Scabby. No treatment.
2. Polaris, Scabby. Disinfected.	6. Polaris, Smooth. Disinfected.	10. Polaris, Smooth. Disinfected.
3. White Star, Scabby. No treatment.	7. White Star, Smooth. No. treatment.	11. White Star, Scabby. No treatment.
4. White Star, Scabby. Disinfected.	8. White Star, Smooth. Disinfected.	12. White Star, Scabby. Disinfected.

It will be seen that the twelve plots were divided into four series.

1st series: Planted with smooth seed, no previous treatment. (Plots 5 and 7.)

2d series: Planted with smooth seed, disinfected with corrosive sublimate before planting. (Plots 6 and 8.)

3d series: Planted with scabby seed, no previous treatment. (Plots 1, 3, 9, 11.)

4th series: Planted with scabby seed, disinfected before planting. (Plots 2, 4, 10, 12.)

The plots upon which the smooth seed were used (Plots 5 and 8) lay upon a slight rise of ground so that the drainage was from these plots toward those upon either side where scabby seed was used. Precautions were taken in cultivation to carry the soil from one plot to another as little as possible.

Unfortunately the wire-worms were very abundant and attacked the tubers so badly as to make exact sorting of the crop upon the basis of its scabbiness very difficult. The following are the general results: There was but little difference in scabbiness between the crops from the first and the second series. Many potatoes from each were slightly scabby,* but none sufficiently so to make them unsaleable.

*This same condition of slight surface scabbiness existed over most of the remainder of our potato plots. These were all planted with disinfected seed, but stable manure was used upon them.

This probably indicates that the scab germs were present in the soil before the seed was planted, although not so abundant as to seriously harm the potatoes. It indicates also that the smooth seed was in this case, practically free from the scab germs, although it must not be inferred that this is always the case. The contrast between the plots of the third and fourth series, that is, between those where the scabby seed was used with and without disinfection, was very marked as is apparent from the following statement of the results:

TABLE SHOWING YIELDS OF TUBERS OF MARKETABLE SIZE, IN OUNCES, AND THE CONDITION OF THESE AS TO SCAB.

Variety of Potato.	Condition of "seed."	Treatment of "seed" before planting	Yields in Ounces.			4. Condition of these marketable tubers.	
			1. Total yield of tubers of marketable size.	2. Unmarketable because of the scab.	3. Total yield of marketable tubers.	Free from scab.	Slightly Scabby.
Polaris	Scabby.	None.	1,143	209	934	298	636
Polaris	Scabby.	Disinfected.	1,368	14	1,354	884	470
Wh. Star	Scabby.	None.	1,307	306	1,001	501	500
Wh. Star	Scabby.	Disinfected.	1,591	None.	1,591	1,310	281

As shown in column two of the yields there was practically no loss of saleable tubers from scab where the seed was disinfected, while there was an average loss of 21 per cent where the seed was planted with no treatment. As further shown in column one, there was a decided increase in total yield from the disinfected seed, amounting on the average to over 20 per cent. The total yields of marketable potatoes (column three) was increased over fifty per cent as a direct result of disinfecting the tubers.

Of course in such a case as this where all the seed potatoes were scabby the gain exceeds what would be obtained in ordinary practice, but it nevertheless emphasizes in a striking manner the practical value of disinfecting seed potatoes where the scab is troublesome. The process of disinfecting them involves but slight labor and an expense of but a few cents for corrosive sublimate.

IV. EXPERIMENTS IN THE PREVENTION OF APPLE AND PEAR SCAB.

The value of Bordeaux mixture as a remedy for apple and pear scab has been demonstrated beyond question. Spraying experiments begun six years ago at the Michigan and Wisconsin Experiment Stations, have been continued with a greater or less degree of success in various states each year since. Reports of satisfactory results in checking the scab on both pears and apples at this Station will be found in Bulletin 28, and in the Report for 1891 and the work has been repeated since with similar results. Vermont orchardists have been slow, however, to test for themselves the value of spraying either against insect or fungus pests. In New York, for example, this is becoming the general practice, while in Vermont it is the exception to spray orchards. The explanation is simple. On most Vermont farms the orchard is secondary to other interests, especially to the dairy. The average farmer has his time so fully occupied with other duties that he is loth to undertake a new one until he is convinced that it will bring a sure reward. Moreover, Vermont, as a State, has climatic conditions which are quite different from those of the more southern and western states, and many of our best orchardists, realizing this, have been slow to adopt practices found successful in distant localities. Led by these considerations we planned to make another thorough test of the value of spraying apples and pears in 1894.

In order to give the results of the work as much practical value as possible the experiments were made in South Hero, in Grand Isle County, one of the finest orchard sections of the State. After visiting a large number of orchards, the one on the farm of Mrs. Lydia M. Root was selected as best suited to the work. Our thanks are due Messrs. T. L. Kinney, Stephen Gordon and L. B. Phelps, for valuable advise and assistance in selecting the orchard and conducting the experiments. This orchard is one of the largest in the State and includes all of the standard varieties of fruit grown on Grand Isle, mostly apples in bearing. It has remarkably uniform soil conditions. The trees of the main portion of the orchard are about 25 years old. All the trees were sprayed in one row extending through the heart of this portion of the orchard, and in addition a number of scattering trees of certain varieties of apples and of Flemish Beauty pears. These scattering trees were selected, following the advise of the above named orchardists, from those varieties especially subject to scab. In another portion of the orchard were two rows of young Fameuse trees, just in good bearing. All the trees in one row of these were sprayed, the other row being left as a check. Altogether about 80 trees were under observation in the experiment, 40 being sprayed and 40 unsprayed.

TABULAR SUMMARY OF THE SPRAYING AND WEATHER.

No. and date of spraying.	*Mixture used.*	*What trees were Sprayed.*	*Condition of trees.*	**Meteorological conditions at time of and following the application.*	
				Rain-fall.	Temperature.
1st application, Apr. 23	Bordeaux.	All trees included in the experiment.	Leaf buds swollen.	Only trace during next ten days.	Warm for time of year.
2d application, May 4.	Bordeaux and Paris green.	All trees included in the experiment.	Leaves expanded.	.85 inch May 5-7, .33 inch May 18-19.	Cool for time of year.
3d application, May 21	Bordeaux and Paris Green.	All but one Fameuse tree.	Last blossoms just falling.	.77 inch May 23-5. 1.41 inch May 28-31.	Cold for time of year.
4th application, June 2.	Bordeaux and Paris Green.	All trees included in the experiment.	Fruit size of marbles.	.63 inch June 1-5.	Cool until about June 8
5th application, June 16	Bordeaux.	Only two-thirds of the trees.†		.67 inch June 27.	Normal for this season.
6th application, July 3.	Bordeaux.	Only one-fifth of the trees.‡			
7th application, July 26	Bordeaux.	3 Fameuse trees.			

Scab spots were found in abundance on both leaves and fruit of the unsprayed trees as early as June 1st, but none could be found on the sprayed trees.

The difference became still more marked as the summer advanced, the scab spots enlarging and new ones developing on the unsprayed trees, while the sprayed trees remained practically free from disease.

* Records made at Burlington, but practically applicable to South Hero.

† Including all varieties under test.

‡ Including only varieties most subject to scab, viz: Fameuse and Winter Strawberry apples, and Flemish Beauty pear.

A glance at the above table shows that while some of the trees were given only four applications, others were sprayed five, six and even seven times. Examinations made during the summer and at the time of harvest failed to show any advantage from the extra applications.

Examinations of the trees in mid-summer showed that the sprayed trees would make a profitable return for this extra care. In order to have visible proof of this fact for the State and the Inter-State fair exhibits in September, 200 apples were picked from a sprayed, and the same number from an adjoining unsprayed tree of the same variety. In each case pains were taken to select trees standing close together, of the same age and equally loaded with fruit. The fruit was taken in all cases from the east side of the tree, picking *all* the fruit within reach from the ground. In this way samples were secured which represented fairly the relative conditions of sprayed and unsprayed trees of each of the following varieties: Flemish Beauty pear (sprayed tree had 4 applications), Fameuse apple (4 applications), Winter Strawberry and Yellow Bellflower apples (5 applications each). The fruit from each tree was then sorted by Mr. T. L. Kinney, one of the most expert judges of fruit in the State, into first, second and third classes on the regular market basis.

The results were as follows :

	1st class.	*2d class*	*3d class.*
Flemish Beauty Pear, sprayed,	94 per cent.	6 per cent.	0 per cent.
" " " not sprayed,	55 "	43 "	2 "
Winter Strawberry Apple, sprayed,	65 "	24 "	11 "
" " " not sprayed,	31 "	45 "	24 "
Fameuse Apple, sprayed,	46 "	28 "	26 "
" " not sprayed,	27 "	29 "	44 "
Yellow Bellflower Apple, sprayed,	47 "	42 "	11 "
" " " not sprayed,	39 "	38 "	23 "

The condition of the fruit from the sprayed and unsprayed Flemish Beauty pear trees is shown in Figures 3 and 4 which are from photographs of this fruit as exhibited at the State Fair at White River Junction and at the Inter-State Fair at Burlington.

The actual profit from spraying was even greater than might appear from a first glance at the above figures. The market value of the No. 1 apples as sorted were just twice those of the No. 2, while the No. 3, or "cider" apples were unsalable.

In the case of the pears, the difference becomes even greater, since the first-class fruit from the sprayed trees was valued by one buyer as worth twice as much as that graded as first-class from the unsprayed tree. Another buyer valued it as worth one and one-half times as much. The seconds of the pears are again worth only one-half as much as the first-class fruit.

Moreover, the fruit from the sprayed trees averaged larger than that from the unsprayed trees.

Taking these elements into consideration and calculating the market values of the sprayed and unsprayed fruit, they become as follows :

Flemish Beauty Pears.

Sprayed, 100.

Not sprayed, 47.

Winter Strawberry Apples.

Sprayed, 100.

Not Sprayed, 63.

Fameuse Apples.

Sprayed, 100.

Not sprayed, 58.

Yellow Bellflower Apples.

Sprayed, 100.

Not sprayed, 83.

The fruit on the remaining trees was picked and sorted in the same way as soon as mature. The condition of the fruit on the entire pear trees showed even greater gains from the spraying than did the above samples taken from the lower branches. With the apples, however, owing to the dry weather, the fruit of the upper branches of even the unsprayed trees was exceptionally fair and the gain from spraying were therefore less marked. The following are the results from the more important varieties:

Variety.	*Relative Values of the Fruit.*		*Gain from Spraying.*
	Sprayed Tree.	Unsprayed Tree.	
Flemish Beauty Pear............	100	46	117 per cent.
Fameuse Apple............	100	79	27 " "
Yellow Bellflower Apple.........	100	81	24 " "
R. I. Greening Apple............	100	82	23 " "

Another decided benefit from the spraying which is not shown in the above estimate, was in the improved keeping quality of the sprayed fruit. Two barrels were filled with No. 1 Flemish Beauty pears, one with fruit from a sprayed tree, the other with fruit from an unsprayed tree. These barrels were placed side by side in a cool cellar. The unsprayed fruit soon softened and began to decay, while the sprayed fruit kept well, until fully three weeks after the last of the unsprayed fruit had decayed.

The amount of gain from spraying was of course wholly dependent on the amount of the disease present. Owing to the remarkably dry weather there

was, as already noted, less scab than usual upon any of the fruit. The Bordeaux mixture preserved the sprayed fruit almost perfectly free from scab. In order to determine the results in this regard more exactly, the entire crop of fruit from one sprayed and a corresponding unsprayed tree of each variety was examined with the following results :

TABLE SHOWING EFFECTS OF BORDEAUX MIXTURE IN PREVENTING THE SCAB SPOTS ON THE FRUITS.

Variety.	*No. of Apples or Pears.*		*Corresponding per cent.*	
	Scabby	Smooth	Scabby.	Smooth.
Flemish Beauty Pears not sprayed....	543	0	100 per cent.	0 per cent.
" " " sprayed.. ..	5	560	1 " "	99 " "
Fameuse Apples not sprayed...	1722	916	65 per cent.	35 per cent.
" " sprayed............	278	2549	10 " "	90 " "
Yellow Bellflower Apples, not sprayed	559	248	69 per cent.	31 per cent.
" " " sprayed.....	16	757	2 " "	98 " "
R. I. Greening Apples not sprayed....	90	286	27 per cent.	73 per cent.
" " " sprayed.......	1	470	0.5 " "	99.5 " "
Winter Strawberry Apples not sprayed	739	174	80 per cent.	20 per cent.
" " " sprayed ..	14	1373	1 " "	99 " "

The results from spraying this orchard may be briefly summarized as follows:

Flemish Beauty Pears: The amount of scabby fruit was reduced from 100 *per cent on the unsprayed trees to less than* 1 *per cent on the sprayed tree; the amount of No.* 1 *fruit was increased from* 55 *per cent on the unsprayed tree to* 99 *per cent on the sprayed tree; the market value of the crop was increased in the ratio of from* 46 *to* 100, *or a gain of* 117 *per cent.*

Fameuse Apples: The amount of scabby fruit was reduced from 65 *per cent on the unsprayed tree to* 10 *per cent on the sprayed tree; the amount of No.* 1 *fruit was increased from* 43 *per cent on the unsprayed tree to* 60 *per cent on the sprayed tree; the value of the crop increased in the ratio of from* 58 *to* 100 *or* 72 *per cent on the lower limbs of the tree, and in the ratio of* 79 *to* 100 *or* 27 *per cent on the entire tree.*

Other varieties subject to scab (Yellow Bellflower, R. I. Greening): The amount of scabby fruit was reduced from an average of about 50 *per cent on the unsprayed trees to about* 4 *per cent on the sprayed trees; the amount of No.* 1 *fruit increased from about* 55 *per cent on the unsprayed trees to* 80 *per cent on the sprayed; and the value of the crop increased in the ratio of* 81 *to* 100 *or* 23 *per cent.*

Four applications of the mixture gave as good results as six or even seven.

V.—OBSERVATIONS UPON THE OCCURRENCE OF OAT SMUT IN 1894.

Extensive examinations of oat fields in various parts of the State were made in 1892 and in 1893. The results as published in the reports of those years showed that there was a remarkably small per cent of oat smut in the State during this period. There seemed no occasion for a continuation of the work on so large a scale in 1894, and accordingly only a small number of fields in the vicinity of Burlington were examined. The results of these examinations were as follows :

Samples taken from	Source of the Seed.	Sound Heads.	Smutty Heads.	Per cent. of smut.
Experiment Farm	Vermont	293	11	0.4
Experiment Farm	Vermont	467	11	2.3
Experiment Farm	Western	384	3	0.8
R. R. Richardson	Vermont	539	4	0.7
Mary Fletcher Hospital	Unknown	799	40	0.5
Peter O'Clair	Unknown	353	13	3.7
Peter O'Clair	Unknown	350	3	1.0
Geo. Durfee	Unknown	303	0	0 0
H. H. Goodell	Western	832	12	1.4

Average per cent of smut in the 9 fields 1.7. The average amount of smut found in 81 samples examined in 1892 was 1.6 per cent. In the 97 samples examined in 1893 an average of only .76 per cent of smut was found. The results obtained from the few samples examined in 1894 thus indicate a slight increase in the amount of smut.

VI.—OBSERVATIONS UPON GRASSES AND WEEDS.

The completed work reported in the previous pages is confined to studies upon plant diseases. In addition, observations and some experiments were begun upon grasses and upon certain weed plants. The grass experiments already begun have in view the selection of some grass or mixture of grasses for use upon overflowed river bottom lands. The only grasses purposely sown at present upon these lands by Vermont farmers are Timothy and Red Top. It seems possible, at least, that some of the native grasses of the State, which are already abundant in favorably situated meadows, may be profitably introduced into more general use. Fowl meadow grass (*Poa serotina*) is the most promising of these, and experiments are under way to test the practicability of its culture.

There are certain weed plants in the State which should be brought more prominently to the attention of the farmers. Among these, the Golden Hawkweed (*Hieracium aurentiacum*) is the most threatening, and experiments testing methods of eradicating it have been begun. The appearance in our State of the similar and closely related Yellow Hawkweed (*Hieracium prœaltum*) may be expected soon as it has been found in northern New York. Another bad weed which is apparently on the increase is Goat's beard (*Tragopogon pratensis*) a species of wild salsify, very similar in appearance to the common "vegetable oyster" of the garden. A still more threatening invader, which is slowly making its way northward through the lower Champlain valley is the Viper's Bugloss or "Blue Devils" (*Echium vulgare*). Two weeds have been causing considerable alarm in the States of the Northern Mississippi valley which have been reported in only a few localities in our State. These are the perennial Sow Thistle (*Sonchus arvensis*) and the Prickly Lettuce (*Lactuca scariola*). The famous Russian thistle (*Salsolă kali tragus*) has not yet reached our borders, but it is approaching New England along the lines of the main railroads, both at the north through Canada and the south through New York State.

Vermont has already enough weed plants with which to contend, and anything that can be done to head off these new invaders will be most profitable. Investigations as to their occurrence and means of eradication will therefore be continued, and in due time the results will be published.

VII. SOME STUDIES UPON CARNATION RUST.

Mr. William Stuart, a senior in the Agricultural Course of the University selected the rust* of the carnation as the subject of his graduation thesis. His studies were carried along three lines (1) effect of various chemicals upon germination of the spores, (2) inoculation of healthy carnation plants with the spores, (3) spraying experiments. The following is an abstract of the results as presented in his thesis.

*Uromyces carophyllinus (Schrank,) Schroeter.

(*a*) *Effects of various chemicals upon the germination of the spores.* These tests were made by depending a drop of the fungicidal solution, in which the spores were mixed, from a cover glass which was cemented by vaseline over a moist (Van Tiegham) cell. Considerable variation was found in the germinative power of the uredospores. Quicker and more vigorous germination was always obtained from spores taken from sori borne upon fresh green leaves, that is from leaves whose vitality had not been appreciably lessened by the fungus. In all cases spores taken from sori borne upon the leaves of the plants gave better germination than did those borne upon the stems. The uredospores do not retain their vitality long after reaching maturity. Spores from leaves collected and dried three months before tested, uniformly refused to germinate. Some hopes were entertained that the teleutospores

from these might germinate, bnt they did not although specimens were kept mounted over two weeks. Fresh uredospores germinated freely in water, good germination being obtained in two or three hours. Considering this as the normal germination, a series of cultures were made in various chemical solutions, to determine if possible the relative effects of these solutions in preventing spore germination, and hence their probable value for fungicidal purposes. About two hundred and fifty separate cultures were made, the solutions used and results obtained being summarized in the following tables:

CHEMICAL USED.	Strength of Solution.	No. of Cultures.	GERMINATION.				Success or Failure as a Fungicide.
			None.	Poor.	Medium	Good.	
Copper Sulphate.	1-100	1	..	..	..	..	Success.
	1-500	2	..	..	..	..	Success.
	1-1000	7	5	..	..	2	Partial Success.
	1-2000	6	2	..	..	4	Failure.
	1-3000	4	2	..	..	2	Failure.
	1-4000	3	2	..	..	1	Unsatisfactory.
	1-5000	3	..	2	..	1	Failure.
	1-10000	1	..	..	..	1	Failure.
(a) Bordeaux Mixture.	Standard.	1	1	..	..	..	Success.
(b)	⅔ "	2	2	..	..	..	Success.
(c)	½ "	2	..	1	1	..	Failure.
(d) Ammonical Copper Carbonate.	Del. Sol.	8	3	3	1	1	Failure.
(e)	½ "	4	2	..	1	1	Failure.
(f)	⅓ stronger	6	3	3	..	..	Partial Success.
(g) Eau Celeste.	1-100	6	4	2	..	..	Partial Success.
	1-500	12	4	6	1	1	Failure.
	1-1000	10	2	2	2	4	Failure.
Iron Sulphate.	1-100	1	1	..	..	..	Success.
	1-500	1	1	..	..	..	Success.
	1-1000	2	2	..	..	..	Success.
	1-2000	4	4	..	..	..	Success.
	1-3000	3	1	1	..	1	Failure.
	1-4000	2	1	1	..	..	Failure.
	1-5000	1	..	1	..	..	Failure.

(a) Six pounds copper sulphate, 4 pounds lime, 22 gallons water.
(b) " " " " " 33 gallons water.
(c) " " " " " 44 gallons water.
(d) Delaware formula, Delaware Bul. No. XXII, 1893; to one volume of 26 Beaume ammonia was added even volume of water. To this was added successive portions of copper carbonate until the solution was saturated. To one volume of the saturated solution, fourteen volumes of water was added.
(e) The one-half strength used was made by adding 29 parts of water to one of the solution.
(f) The one-third stronger solution was made by diluting the saturated solution with nine parts of water. The latter strength seemed to be about the dividing line between germination and no germination.
(g) This solution was highly recommended in the *American Florist* as a sure remedy for rust. Their formula assuming 50 gallons to the barrel, reduced down to the basis of 1 gram to 100 c. c., gave .035 grams sulphate of copper and 26 c. c. ammonia to 100 c. c. water. Good germination was obtained with this strength, and even some germination took place in a solution of 1-100, which was twenty-eight times stronger than that recommended in the *Florist*. That such a fungicide should give beneficial results seem hardly compatible with the results obtained from the cultures made.

CHEMICAL USED.	Strength of Solution.	No. of Cultures.	GERMINATION.				Success or Failure as a Fungicide.
			None.	Poor.	Medium	Good.	
Potassuim Sulphide.	1-100	2	2	..	..	..	Success.
	1-500	6	6	..	..	..	Success.
	1-1000	8	3	4	..	1	Failure.
	1-2000	6	2	2	2	..	Failure.
	1-5000	2	1	..	..	1	Failure.
	1-10000	2	..	1	..	1	Failure.
Potassium Chromate.	1-500	1	1	..	..	..	Success.
	1-1000	6	2	3	..	..	Partial Success.
	1-2000	8	3	3	2	1	Failure.
	1-3000	2	..	..	2	..	Failure.
	1-5000	4	..	..	2	..	Failure.
	1-10000	3	..	1	..	2	Failure.
Potassium Bi-Chromate.	1-500	1	1	..	..	..	Success.
	1-1000	5	1	4	..	..	Partial Success.
	1-2000	7	1	5	1	..	Failure.
	1-3000	3	1	2	..	..	Failure.
	1-5000	3	..	2	..	1	Failure.
	1-10000	1	..	..	..	1	Failure.
Lead Acetate	1-500	4	4	..	..	..	Success.
	1-1000	4	..	2	..	2	Failure.
	1-2000	2	..	..	..	2	Failure.
	1-5000	1	..	..	..	1	Failure.
Corrosive Sublimate.	1-500	2	2	..	..	..	Success.
	1-1000	4	4	..	..	..	Success.
	1-3000	3	..	3	..	..	Partial Success.
	1-5000	8	4	1	..	..	Failure.
	1-10000	6	2	..	2	2	Failure.
Carbolic Acid	1-100	2	2	..	..	..	Success.
	1-200	5	1	1	2	1	Failure.
	1-300	2	..	..	..	1	Failure.
	1-400	1	..	..	1	..	Failure.
	1-500	1	..	..	..	1	Failure.
	1-1000	1	..	..	..	1	Failure.
	1-5000	1	..	..	..	1	Failure.
Salt	1-100	4	2	..	1	1	Failure.
	1-500	3	1	..	1	1	Failure.
	1-1000	3	1	..	2	..	Failure.
	1-2000	2	..	1	..	1	Failure.
	1-5000	2	..	..	..	2	Failure.

(2) *Inoculations of healthy carnation plants with the spores:* A series of inoculations were made under various conditions. Five weeks later microscopic examination of the tissues of the plants in the vicinity of the inoculations detected the presence of the mycelium in several cases. These were all cases in which the epidermis of the plant had here broken by needle puncture. In no case where this was not done was the mycelium found. No sori were found, the time being too short.

(3) *Spraying Experiments:* In order to ascertain whether the chemicals used in the germination tests could be used without injury to the plants two plants were sprayed June 12, with each of the following solutions. The strength of solution used in each case is that which prevented spore germination. The final examinations of the plants made July 29, showed no perceptible injury in any case:

No. I. Potassium Chromate, 1–500.

No. II. Potassium Sulphide, 1–500.

No. III. Potassium Bichromate, 1–500.

No. IV. Potassium Iron Sulphate, 1–500.

No. V. Copper Sulphate, 1–500.

No. VI. Lead Acetate, 1–500.

No. VII. Corrosive Sublimate, 1–500.

No. VIII. Carbolic Acid, 1–100.

NOTICE. The following, written as a footnote to report of the experiments with Bordeaux mixture upon potatoes, was by mistake omitted from its proper place and is inserted here:

The first observations upon the value of Bordeaux mixture in checking insect attacks upon plants were made by Prof. H. Garman of the Kentucky Experiment Station in 1889. These observations are recorded in second Annual Report of the Kentucky Experiment Station, issued in 1892, and in Agricultural Science of March, 1892. These did not come under notice until after the publication of our observations along similar lines made in 1893.

Report of the Entomologist.

G. H. Perkins.

Vermont does not appear to be as liable to serious insect attacks as are many states. Probably this is due to the natural conditions of soil, vegetation, and especially climate, which exist in this state, and much the same is true all over New England. Nevertheless, the depredations of insects in Vermont are by no means small, and the annual loss to every farmer, gardener and fruit-grower, if it could be accurately ascertained, would be surprisingly large. For the reason that we are not startled into activity against our insect foes by some unusual or overwhelming devastation, we are in danger of surprise by a stealthy foe. The losses may be nowhere so great as to attract public attention, but losses there are wherever anyone is trying to raise any crop, and in the aggregate the loss is great. Not only do the old and well known enemies continue their work of destruction, but new species from time to time make their appearance, while an old and comparatively harmless species is at any time likely to come into prominence by its suddenly increased destructiveness and distribution. On this account, as prevention is always better than cure, it is only the part of wisdom to exercise constant vigilance and to promptly check any depredation, even though it may appear to be, and really is, of very little importance. In this way, and only so, will it remain true that extensive outbreaks of injurious insects may be prevented. If the outbreaks that are not extensive are persistently controlled, those which are alarming may not occur. As has been said before, if everyone in the state will do his part in waging war against such foes as may be at hand, they will in all probability be kept within reasonable limits. But it is always to be remembered that a little carelessness here or there may easily undo the care and labor of many. Not only promptness, but unanimity of action is essential to the best results, so that it is every man's interest not only to see that he does his own duty, but also to encourage his neighbor to do his. I think the outlook was never more encouraging than at present, so far as the warfare against insects is concerned, for there has never been so much interest in the subject of injurious insects manifested as now. Just so far as people realize the importance of attending to such insects as are ravaging their crops, and just so far as they are willing to use care, time and money in exterminating them, just so far will they succeed in preventing the inevitable losses which result from carelessness or indifference.

That greater attention than heretofore is being paid by the people of the state to this subject is indicated by the increasing number of inquiries and of specimens which come to the Station. It is of the greatest importance that, whenever possible, the insects concerning which information is desired, be

sent with the inquiries. A good way in which to send small insects by mail is to bore a hole two or three inches deep in a small block of wood, one just enough larger than the hole to furnish strong sides, and close it with a cork. Many insects are sent in pasteboard boxes and are generally crushed before they reach their destination. Wooden or tin boxes should always be used and the food plant be enclosed with the insect. It is not uncommon to find in insects of very similar appearance, very dissimilar habits, and it is easily understood that descriptions alone, especially if written by one unused to such description, of closely allied species, or such as closely resemble each other, would not be sufficient to enable an entomologist to give intelligent reply to inquiries concerning the species, but if he can have the insect itself at hand for examination, doubt becomes certainty and much time and trouble will be saved.

The San Jose scale has attracted much attention among fruit growers and, although so far as I am aware, it has not appeared in this state, it is evident from inquiries that have come in that some of our fruit raisers are anxious lest it appear and prove as destructive here as it has elsewhere. As there seems to be a desire to recognize this insect should it appear, it may be well to give a brief description at this time, to be followed, should it make its appearance within our limits, by fuller account and ample illustration. Several specimens of the common oyster-shell bark louse have been sent to the Station by those supposing, or at least fearing, that this insect was the San Jose scale from which it is very easily distinguished, although it is allied to it. In the first place the San Jose scale is very little elongated and usually is perfectly circular and by this character alone it may be recognized from any of our common scales, which are all long and narrow, or at least long oval. The San Jose scale is also smaller than others, being usually not over one-sixteenth of an inch in diameter, though if not very numerous or crowded they may reach twice this size. The scales are quite flat except at the center where each is raised into a little papilla, which may be yellow, but is usually black. The scales are so small that when crowded on a branch or twig they are not readily seen without a magnifying glass. In such cases they appear to the unaided eye like a gray powder or scurf, until the surface is rubbed when the crushed insects produce a yellow, oily fluid. Ordinarily the bark under them is darker than the scales, as may be seen when they are scraped off. The scales grow lighter in color as they are older. Not only the smaller limbs may be infested, but the whole trunk and also the fruit and leaves. It is not my design to give here an account of the life history of this insect in its varied and interesting transformations, but a few words as to its manner of spreading may not be useless. Most of the facts given are taken from Insect Life, Vol. VI., p. 367. An article may also be found in the Report of the Department of Agriculture for 1893, with a plate of the insect, to which those interested are referred.

It has been found that the minute scale larvæ are carried by more active insects, as lady birds, ants and others. The little larvæ get on the backs

of such insects as may be crawling about the trees on which they are hatched and thus secure free transportation to other trees. It is to be noticed that the scale is active only for a few days and that when the female is fairly grown and the scale formed over her she is not able to move about. Hence the migration and spread of the insect must take place during the few days of larval activity. When trees are so near that their branches are in contact at any time, of course the larvæ could creep from tree to tree, but the principal method by which the scale spreads from tree to tree is by riding on larger and more active insects. That this insect will be found in Vermont is very probable, for it may easily be brought on nursery stock, but is my belief and hope that it will not be a serious pest for the reason that it is a southern insect, having first appeared in California and was for a long time confined to that immediate region. Recently it has been found in Virginia, about Washington, Delaware, New Jersey, and even New York, but while it may very probably appear in New England, I hope that it may not be very injurious but find our climate too severe and changeable for its welfare. Nevertheless, it will be very wise for everyone who imports and sets out trees to carefully examine them, and it is also well to examine trees which have been set out within the last few years, especially if they have come from localities south of this state. Should trees be found infested they had better be burned, if they are badly attacked, if not the scales can be brushed with a kerosene emulsion used pretty strong, or very strong soap suds or lye water. There is no harm and possibly benefit in washing all new trees with one of these before setting, especially if there is any reason to suspect the presence of this or other species of scale. It has been thought best to say as much as this concerning an insect which is likely to be found at any time in our state, in small numbers we may hope, but which in any number is a most undesirable and vicious intruder. Specimens suspected of being the San Jose scale may be sent to the Station very conveniently and will receive prompt attention.

Without desiring to repeat what was said last year concerning the advantages of observation of insects, both to the observer and to agriculture in general, I do wish to add so much of emphasis as I may to what was written in last year's Report, by again calling attention to this subject. If we can only have as many students of entomology in Vermont as there are farmers, including their families, we shall soon know more of the habits of insects, and for this reason be able to contend with them far more successfully than now. By student of entomology I do not mean one who gives his chief attention nor the greater part of his time to the subject, but anyone who can and will notice the doings of such insects as he may see, as he cares for his crops or fruit trees. I do mean those who desire to know all they can and are willing of mind and open of heart with respect to a knowledge of such creatures as come in their way. Every branch of science has been greatly advanced by unscientific, but eager and industrious workers, and such help is of especial value to entomology. So dependent is economic entomology upon the co-operation of agriculturists and so important do I consider such co-operation,

that I give the farmers fair notice that, in one form or another, I shall reiterate my entreaties until the object for which I make them is in some measure, at least, attained. I am quite sure that, aside from all pleasure which comes inevitably from the study of any natural objects, insects as well as others, not a little financial benefit will accrue because of the increased attention given to insects and therefore more diligent use of remedies, and also because of the greater knowledge of their habits and therefore more certain methods of destroying them. But observation and study, valuable as these are, do not fill full the measure of the farmer's duty. In order that the observations may be of full value they must be made known so that others may have the benefit of them, and that the work of all may be the property of each worker. How much observation there has been the past year I do not know, but if we are to judge by the reports of such work which have come to the Station, very little. I presume, however, that this is not a fair test and that there have been many more observations than reports. Now every fact, however trifling it may appear, in the life history of an injurious or beneficial insect is of value to those who are especially studying them, and it may be just the little portion that has long been lacking to make the history complete. It is very commonly true that the life history of an insect can be written through all its stages, except one or two, and these are needed in devising remedies. For example, almost the entire life history of the June bug is known except where and how it lays its eggs. Concerning this authorities differ so widely that it is evident that we do not know. Therefore, let no one hesitate to report to those who can make use of facts, all that have come under his notice. Of course many, probably most of them, will not be new, but at any time the new and much desired fact may come. It may seem to some that the study of economic entomology is not worthy the attention of grown men and women. Some of the bugs studied are small, very small, but their structure is in its way as complex and wonderful as that of an elephant and quite as worthy of study. Anyone who undertakes to follow in all its devious and strange transformations the life of even a very small insect, will discover that his task is by no means a small one. No one considers it too insignificant business to apply to injurious insects such remedies as may be thought efficient, but a necessary preliminary to such remedies is a knowledge of the life habits and structure of the insect committing depredations, and if the remedy is important, so is the life history, without which remedies are used very inefficiently and only by guess. The only method of becoming really acquainted with insects is to study the living forms as they carry on their daily life, and yet books may help in this. Some years ago I mentioned a few of the best works such as Harris' *Insects Injurious to Vegetation*, a classical work in entomology and one that can never be superseded. Then, most excellent and helpful are Packard's *Guide to the Study of Insects*, Saunders' *Insects Injurious to Fruit*, and several more. A work very recently published, which I think meets the need of the farmer and fruit grower more completely than any other is Comstock's *Manual for*

the Study of Insects. It is especially valuable in that it not only describes the various insects most likely to be found, but whenever possible the remedies are stated. The work is large, fully and well illustrated and costs at retail $3.75.

INSECTICIDES.—A few new insecticides have been introduced during the year, but none of any especial value so far as I can judge, while some formerly much advertised have passed into deserved oblivion. The arsenites, especially the well tried Paris green, still hold the first place as remedies for many species of insects, as does kerosene emulsion, formulas for preparing which may be found in the Fifth Report of this Station. An enumeration of the more common, most easily attained and most efficient insecticides will answer many inquiries and I hope prove convenient and useful.

All or nearly all leaf-eating insects can be kept in check by using *Paris Green* one pound to 150 gallons of water. This will kill most insects and not generally injure the foliage. Soft bodied insects, such as plant lice, scale, and the larvæ of many species may be destroyed by *Kerosene emulsion*. A very conveniently prepared emulsion, where milk is abundant, may be made by mixing two parts of kerosene with one part of milk, preferably sour, and churning the mixture thoroughly until a sort of butter is formed. No heat is needed, but this emulsion does not keep long unless in closed jars. When used it is to be diluted with about twelve parts of water. Other emulsions may be made by the formulas referred to above.

Wherever practicable hand picking is always effective. This sometimes seems to involve great expenditure of time and labor, but it is usually found to be less tedious than was anticipated. *Kerosene* is very efficient when it can be used. *Bisulphide of Carbon*, *Benzine*, *Naptha*, etc., are all excellent when they can be poured upon insects or their eggs, and especially are these substances of value when infested articles can be shut up in a tight box and then one of the above fluids poured over it and the box shut tightly for a short time. These are all very inflammable and many persons are afraid to use them on account of the danger of fire, but they are so volatile that a few minutes airing suffices for the escape of the vapor so that danger of a conflagration or explosion is soon passed should a light or flame be brought in contact with the air of closet or box. Of course it will be understood that there is no danger at any time if fire is not present.

Corrosive Sublimate.—A very convenient method of protecting carpets, or other articles in danger of being eaten, especially if they must be left unwatched for a time, is to wash over the edges, or, if the article is small, to dip it in, or thoroughly moisten it with, a solution of corrosive sublimate in water. Water is not a very good solvent for this material, but it answers excellently for the purpose named, since the solution is strong enough to destroy insects, but not so strong that it leaves a white coating after drying as does a stronger alcoholic solution. In the case of carpets it is perhaps the most convenient method of applying this substance to use a paint brush and

simply paint the edges of the carpet on upper and under side for three or four inches, and also the floor or lining immediately beneath the carpets, that is about the base boards. The only objection to the use of corrosive sublimate is its extremely poisonous character, but only when taken into the stomach. It is not harmful to the skin, in fact it is much used in surgery for sores, etc., and is a good antiseptic. A very weak mixture of *Sulphuric acid* and water, one part to fifty, is said to be a good remedy for some insects.

Sulphate of Copper or Blue Vitriol, one ounce dissolved in two or three gallons of water, is very useful as a remedy against soft-bodied insects, especially larvæ.

As indicated in the last Report by Professor Jones, the *Bordeaux mixture* seems to be quite efficacious in case of flea-beetles.

Quassia.—This is used by English gardeners and to some extent in this country, for insects infesting roses and other shrubs and plants, One pound of quassia chips is soaked in water making an infusion, water being added to the whole to make, when used, eighty gallons. A less quantity may be made, but in similar proportion should be used.

Strong *Soap Solution* is often the most convenient remedy for scales, mealy bugs, plant lice, etc., though in most cases I think it is inferior to kerosene emulsion.

Insects, such as climbing cut worms, codlin moth, or any other species which either feed at night and hide from daylight or which seek concealment when about to pupate, may often be entrapped by placing bands about the trees which are infested, or chips, bits of board and the like on the ground under which these insects will creep, and where being found they can be destroyed.

Cut worms may be destroyed by placing poisoned bunches of clover, grass, lettuce, etc., about their haunts.

Tansy tea, when strong, is reported to be efficient in destroying or repelling many insects.

Hellebore applied dry, or better mixed with water in the proportion of one-half ounce to a gallon, is sprayed or sprinkled over infested plants, is good against many species. It is less certain than Paris green, but is less dangerous as a poison and more agreeable to handle.

Pyrethrum, Bubach, or *Insect Powder*, is not poisonous, but is effective against many insects. It is important that it be fresh, as it speedily loses its strength if old. It can be used dry, but better sprayed or sprinkled over plants in the proportion of one ounce in two gallons of water.

A new insecticide, new to us in this region, is *Ermischs' Insect Lime*, a German preparation, which is sufficiently well recommended to entitle it to a trial. It is a sticky paste to be spread upon bands which are placed about trees to protect them against climbing insects, such as canker worms, climbing cut worms and the like. I cannot speak of this according to knowledge, for I have not been able to give it a fair trial, but I think it likely that it

will prove very useful as it appears to have done in Europe for the protection of trees as indicated. I doubt very much, however, whether it can be of much value against such insects as codlin moth, etc., which fly to the branches or blossoms to lay their eggs.

In the choice of that which follows I am guided, as in previous Reports, more by the inquiries which have come to me than by my own inclinations. Every working entomologist finds original investigation very attractive, much more so than the reiteration of admonitions or warnings or the consideration of old and well known species, but, so long as he finds a demand among those for whom his Reports are especially designed for more information concerning species which are more or less familiar to special students of insect life, he must devote himself to these and confine his investigations to these if he can do no more.

HOUSEHOLD PESTS.

In a recent Bulletin of this Station, (No. 43), the writer attempted an account of some of the more common insects which infest our households. The space then available did not admit of a consideration of all the insects concerning which information has been desired and advantage is taken of the present opportunity to complete that account.

Less commonly seen in our houses than the clothes and carpet moths, considered in the above mentioned Bulletin, is a small, dingy beetle known to entomologists as *Dermestes lardarius*, L. It is not usually injurious to any noticeable extent in our homes, but in storehouses, museums and similar places, it sometimes makes itself very unpleasantly conspicuous. It does not attack clothing, but any dead animal matter is quite in its line. I have had more trouble in our college museum from this insect than from moths, and in storehouses containing hams or dried beef it may do much mischief. The adult insect is of the form shown in Figure 1. It is an active beetle about a third of an inch long, in color a dingy black, except on the upper ends of the wing covers which are crossed by a broad band of dusky yellow, as the figure shows. This band is quite indistinct in some specimens unless closely examined, but usually may be seen clearly. The larva, Figure 1, a, is a chestnut brown, worm-like insect, covered sparsely with long hairs, which, when sufficiently magnified, are seen to be barbed as shown in Figure 1, b. When grown the larva is about half an inch long. These larvæ are very persistent in their efforts to get at dry animal matter and will often bore through coverings which enclose that upon which they feed. I once found a large number of vials, containing shells which had received the attention of Dermestes. The shells had been collected alive, dried, and on account of their small size been placed in the vials.

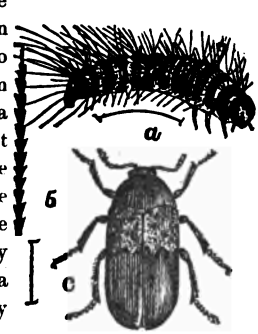


FIGURE 1. *Dermestes lardarius*. *a*. larva. *b*. hair of larva. *c*. beetle enlarged.

The cork of every vial was very neatly bored and thus the larvæ reached the very dry remains of the animals in the shells. In this case the depredations of the beetle were no injury, but often they devour skins, ligaments, etc., to their great damage, The insect has been called the ham beetle because of its injuries to hams hanging in the storeroom. Dried beef, honey comb and cheese all suffer from its depredations. It increases rapidly and, if unchecked, may do great mischief. On the other hand they are easily seen and caught and perhaps this is the best method of dealing with them, though where they are very numerous, cheese ground up and mixed with Paris green or arsenic may be placed where they will get it, or if possible, the skins or other articles likely to be eaten, may be poisoned with arsenic or corrosive sublimate. Bits of old cheese placed here and there in the haunts of Dermestes will attract them and make it easier to find and destroy them. A similar species *Dermestes vulpinus*, attacks skins and leather sometimes very destructively. There is another ham beetle which has sometimes done much damage.

FIGURE 2. *Corynetes rufipes*. *a.* larva. *b.* pupa. *c.* cocoon *d.* beetle enlarged. *e.* bettle natural size. *f.* larvæ egg. *g.* larvæ jaws. *h.* larvæ labium. *i.* larvæ antenna.

This is the Red-legged Ham-beetle, *Corynetes rufipes*, Fabr., shown in Figure 2, with larva, pupa, cocoon and mouth parts of larva. This beetle is not at all like the preceding in appearance. Its color is steel blue with, as the name indicates, red legs. When the surface of the wings and body is magnified it is seen to be covered with fine hairs. The eggs are laid upon the ham wherever the covering is in anyway broken. They hatch in a short time into white worms with brown heads. As the larva matures it becomes dingy or grayish white. This insect is sometimes known among dealers as the paper worm, because the larva when about to pupate makes a cocoon, Figure 2, c, of a paper-like substance. According to Dr. Riley, the beetles appear about the middle of May when the eggs are laid. As the larvæ do not seem to be able to eat through any covering, hams that are thoroughly encased are not exposed to injury from this insect. And it may be said that the injury which both this and the Dermestes inflicts is rather in appearance than in reality. The substance of the meat is not in any way affected, only those portions where the larvæ have actually fed are to be discarded, and these may be easily removed.

Among household pests may be reckoned *Ants*. There are two sorts which most commonly invade the house, the little red ant and the larger black ant and of each of these there may be several species. When these are troublesome various remedies may be adopted. The common little red ant, *Monomorium pharaonis*, can be attracted in large numbers to a sponge saturated with sweetened water, and when this is well filled it can be dropped into scalding water and a few repetitions of this will remove the pest; or, these

as well as black ants, may be destroyed by poisoned molasses or other sweets. It is asserted that certain aromatic oders are very disagreeable to them and will repel them. Pennyroyal, sassafras, etc., are of this sort. Not infrequently owners of lawns are disturbed by the large and increasing piles of sand which are made by the black ants, usually, *Camponotus pennsylvanicus*. These may be destroyed best by using bisulphide of carbon. With a sharpened stick make a hole down into the nest several inches deep and an inch or an inch and a half in diameter. Then, having secured a lump of clay and a few tablespoonfuls of the bisulphide, pour the liquid into the hole and quickly close it at the top with the clay and, if the soil is sandy or porous, throw a wet blanket or something of the sort over the whole nest. This will usually effect the destruction of the occupants of the nest, since the vapor of the bisulphide penetrates every part of the galleries, etc., made by the ants. It is said, however, that the best results are obtained by removing the covering after ten or fifteen minutes and igniting the vapor. A second application of the treatment may be necessary if the nest is large. Kerosene or kerosene emulsion may be poured into a nest instead of bisulphide and may answer the purpose very well, but usually these will not be found to be as effective as the bisulphide. Mr. M. C. Read writes (Insect Life, Vol. 2, p. 252) that he has succeeded in getting rid of ants on his lawn by first breaking up the nest and then turning a large flower pot over it. "The ants immediately appropriate the jar, remove their larvæ to it and fill it with pellets of earth. I then drench this with kerosene emulsion reduced to a strength of two or three per cent, which will kill every ant thoroughly drenched with it. It is more destructive than pure kerosene, which does not adhere to them." Insect powder is also destructive to ants and if used freely, especially if the place where they enter the house can be discovered and the powder scattered about there in abundance it may put an end to the trouble. As an instance of how easily a pest which has become serious may be removed, I may quote the following from an article by Dr. Riley in Insect Life. "A case was brought to my notice two years ago in Washington, where a fine old homestead was on the point of being sold on account of the annoyance caused by these ants (the large black one). An investigation showed an enormous nest several feet in diameter in the back yard, and several colonies here and there in other parts of the premises. The large colony was completely destroyed by the use of bisulphide of carbon. A teaspoonful was poured down each of a number of openings, and a damp blanket was thrown over them for a few minutes. Then, the blanket being removed, the bisulphide was exploded by means of a light at the end of a pole. The slight explosions drove the poisonous fumes down through the underground tunnels, killing off the ants in enormous numbers. The main source of trouble being thus destroyed, the nuisance was greatly lessened, and all talk of selling the old place has ceased." Of course it is understood that ants do not usually do damage to anything, that is, such ants as those mentioned, but are simply a nuisance because of their presence where it is quite undesirable.

In our usually well kept New England homes there is little need to pay much attention to certain pests which invade less thriftily kept dwellings. and yet, in spite of every precaution, unwelcome visitors will sometimes disgust the housekeeper. One of these is an insect almost or quite unknown in some parts of the country, but quite common in other parts, and which may at times intrude into even well regulated families. This is the Bed-bug, *Acanthia lectularia*, L. No description of this insect is necessary I think, though doubtless there are those in Vermont who, having never traveled, have never seen one. When once introduced, the pest may become very troublesome, as it is able to live for months without food, and it is also capable of great increase. The most efficient destroyer of the insect is benzine or bisulphide of carbon, thrown with an atomizer into the cracks in which it hides. An old remedy is painting those parts of a bedstead likely to harbor the bugs with a strong solution of corrosive sublimate, but I doubt if this is as efficacious as benzine. The bugs do not eat the bedstead and I can see little use in poisoning it, but if the insects can be reached by benzine or bisulphide of carbon they will be finally destroyed. So, too, if the bugs are powdered with insect powder it will destroy them.

Under the same category with the insect just named comes the Flea. This pest may be treated to a dose of insect powder, if it remains long enough in one locality, or kerosene emulsion. A domestic animal infested may be dusted with the insect powder or washed with diluted kerosene emulsion. As the eggs are deposited about the kennels or other haunts of the animals, these must be kept clean and washed, or at least sprinkled with emulsion.

Less disgusting, but far more commonly troublesome pests are the house fly and the mosquito. These pests do their chief injury to man by damaging his good nature and checking his onward movement towards saintliness. It is a question worthy of some consideration how many of us have fallen short of that excellence of disposition and attractiveness of character to which we might have attained had it not been for the baneful influence of house flies and mosquitoes. Unless it be true, as some assert, that these and some other insects are carriers of disease germs, they do not commit any positive injury, they are not depredators, but rather tormentors. Although so over common as it is, the life history of the house fly is very little known, and a few facts respecting this will not be uninteresting. To Dr. Packard more than to any other American entomologist we owe the working out of the development of the house fly and many of the following facts are obtained from his account. Dr. Packard thinks that the common house fly of Europe is identical with that of this country, and it is not impossible that the same species is found all over the world. It is a very ancient pest as it is mentioned in old Sanskrit writings as in very ancient days the same annoying insect that it is now. August seems to be the time of its especial abundance, and probably it is then more prolific than at any other time. The eggs are not deposited in or about the houses which the flies frequent, but on fresh manure, especially about stables. These eggs, of which a fly may deposit

many, Dr. Packard having observed that one confined in a bottle laid a hundred and twenty between six in the afternoon and eight the next morning, hatch in about twenty-four hours into white, cylindrical maggots tapering from the posterior to the anterior end. It lives buried in the moist manure, changing its skin twice and in rather less than a week enters the chrysalis, or pupa state in which it remains about as much longer and then comes out as a perfect fly. During the winter a few of the many that have hatched live in a semi-dormant state, to become in the spring as lively as ever, but most die in the fall when frosts come, after a life of six weeks or so. It is comforting to those who are tormented by flies to know that in turn flies are tormented by mites which are parasitic upon them, and also in the fall a fungus disease destroys many. It does not appear quite certain that the house fly never lays its eggs upon other substances than horse manure, indeed, it would appear certain that they do, for an English naturalist has studied the development of what he asserts to be the house fly, from eggs laid on fresh liver. Popular Science Monthly, Vol. XV. p. 618.

As to remedies I have nothing better to suggest than the use of insect powder, which is familiar to all housekeepers, as are numerous other more or less effective methods of repelling or destroying these insects. The species mentioned in the foregoing pages, together with the carpet beetle and clothes moths, figured and described in Bulletin No. 43 of this Station, completes the list of the common pests of the home.

PEA AND BEAN WEEVILS.

The *Pea Weevil*, *Bruchus pisi*, L, is an old and troublesome enemy in some parts of Vermont, especially the northern, where peas are raised for winter use in considerable quantities. Although familiar to most, it may not be out of place to give an illustration showing the larva and perfect insect considerably enlarged, as thus characters not readily seen with the unaided eye will be made plain. Gardeners and farmers often are puzzled to know how the weevil makes its way into the pea, enclosed as it is in the pod, without leaving some sign of its entrance. The egg, which is very minute, is laid on the little pods just after they are formed in the flower, and these soon hatch and the little grubs at once bore into the pod and locate in the forming peas, one in each, where they live and thrive on the substance of the pea, often leaving the germ untouched so that infested peas will often grow and for a time do well, but they are most likely to be found wanting when

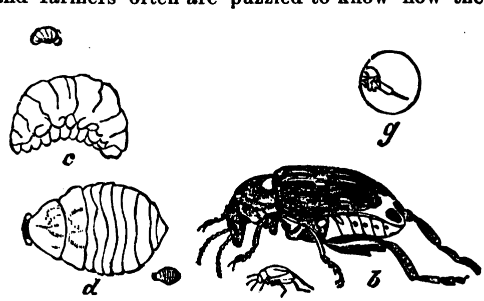


FIGURE 3. *Bruchus pisi*, Pea Weevil. *b*. beetle enlarged and natural size. *c*. larva enlarged and natural size. *d*. pupa. *g*. pea infested with the beetle.

the harvest is gathered, as they do not produce well at all. The beetle is a small black and white insect of the form, well known to many, shown in Figure 3, b, as is the larva at c.

Closely resembling and allied to *Bruchus pisi* is *Bruchus obtectus*, Say, the Bean Weevil. This insect has not been reported as troublesome in Vermont until the present year, though it is by no means a new insect. The bean weevil differs from the pea weevil in its much smaller size, the adult beetle being only about a tenth of an inch long, in its greater sharpness anteriorly, its more ovate outline, its lighter color due to a greater proportion of white blotches and spots. In the pea weevil the projection of the abdomen beyond the wing covers is very marked, while in the bean weevil the wing covers are nearly as long as the abdomen. The bean weevil lays its eggs not on the pod, but inside, the female being able to cut or gnaw a slit into which the eggs are thrust. When abundant the bean weevil is more destructive than the allied species, often destroying the crop completely or, if not, greatly damaging it. All varieties of beans are liable to attack and the insect is very prolific and often occurs in great abundance. Dr. Lintner gives an instance of this as follows: "From two quarts of beans, which had been kept for seed, over a teacupful of beetles were taken."

Fortunately it is not very difficult to check or even prevent this pest from doing harm, and the same methods avail equally as well in case of the pea weevil. Obviously the first thing to attend to is the destruction of infested seed or at any rate not planting it. It may do for food for stock but it is very unprofitable to use it for seed, since although both peas and beans which have been occupied by weevils may grow well for a time, they are almost sure to give poor returns for the time and labor expended upon them. The pea weevil does not continue to breed and live in stored peas, but the bean weevil does. If infested peas and beans are to be fed to stock rather than burned, they should be shut up in a can or bin that is tight and treated with bisulphide of carbon. Saturating the peas or beans with kerosene kills the weevils, but, while it does not destroy the germinating power of the seed, it it must render it distasteful to stock, which the bisulphide does not, and as has already been shown, it is not good policy to use infested peas or beans for seed.

CURRANT WORMS.

Without attempting a complete list of the insects which attack currant bushes in this state, I will give figures and brief accounts of some of the more common and injurious. These are all familiar to many who will read these pages, but there are many others who are seeking information concerning them. The three most common and most destructive species which we have are the currant borer, *Sesia tipuliformis*, and the two currant worms, *Nematus ventricosus*, and *Diastictus ribearia*, the first the larva of a saw fly, the last a measuring worm, the larva of a moth.

The currant borer is also the larva of a moth, though a moth of such unusual appearance that few recognize it as of that group. It is more likely to

be taken for a fly or some sort of a wasp. Its general form is shown in Figure 4, but its beauty and graceful movements cannot be shown in any figure. The wings are for the most part transparent, are elegantly and most delieately fringed with dusky hairs. The general color of the body and wings is an elegant dark blue and the whole surface is like satin. Across the abdomen are bands of yellow. It is about three-fourths of an inch across the spread wings. The beauty of the insect appears more clearly when it is seen through a moderate magnifying glass. The moths appear about the middle of June, varying with the earliness or lateness of the season, from June 1st to June 22d in Burlington. The male is usually considerably smaller than the female, and varies much more in size in different individuals. Those which I have taken here in Burlington were of all sizes from .57 inch across the expanded wings to .74 inch, while the females do not vary greatly from .76 inch. The yellow bands which cross the abdomen also differ somewhat in the males and females, being in the latter broader and of deeper color and therefore more distinct, and the tuft of silky hairs at the end of the abdomen is generally thicker than in the male. In the females there are rarely more than three abdominal bands, while in some males there are four and even five, though three is the usual number in all.

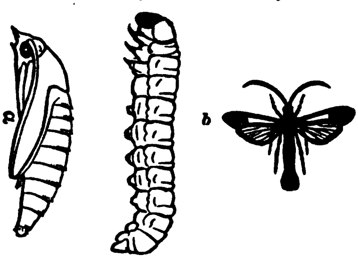


FIGURE 4. *Sesia tipuliformis*, L, Current borer. *a.* pupa. Middle figure, larva enlarged. *b.* moth natural size.

The eggs are laid during June on the twigs into which the larvæ bore until they reach the pith in which they live. The general appearance of the larva is well shown in Figure 4, middle figure. It is a white grub with a brown head and feet and a dark line across the back. It lives in the pith of the stem in which it is located through the summer, fall and winter, changing to a chrysalis from which it emerges as indicated above in June. Before the larva changes to a pupa it gnaws a hole outward from its burrow nearly through, leaving only a very thin skin of bark, otherwise the moth when it emerges from the pupa would be securely imprisoned in the wood and perish, for it would be wholly unable to make its way out. If by some means the larvæ could be made to forget to prepare the way for the escape of the moth as stated, this would be the best remedy conceivable, but it does not forget and our currant bushes suffer greatly in consequence. For reasons which I cannot discover the insect is, at least in this region, quite peculiar in its distribution. In some gardens and in some portions of the town it is so abundant as to almost prevent the growth of currants, while other gardens and parts of town, for no apparent reason, are nearly free from the pest and have been so for years. The most obvious remedial measure is to cut off and burn all infested branches, and if this is done during the fall or winter much good may be accomplished. Choice bushes may be painted over, and it must

be done thoroughly, with strong kerosene emulsion during the last of May in order to prevent the insects from laying the eggs. I have seen the small, downy woodpecker at work on currant bushes and I have no doubt it was after this borer. The moths are very active during the warmer parts of the day, but in the cool morning air they are sluggish and may be quite easily captured, and in infested localities it would be quite worth while to watch the bushes every morning from the first to the middle of June, and with some sort of small hand net capture the moths as they appear.

More easily noticed and dealt with is the common currant worm, one of the span or measuring worms, *Diastictus ribearia*, Pack, shown in Figure 5. This is sometimes our commonest pest and completely defoliates the bushes. The worm, Figure 5, is in general of a yellowish color with about nine black dots on each segment. The head is yellowish with black spots, while the jaws and feet are black. On the sides are white lines. There are sixteen legs and four posterior legs. It grows to about one inch in length. In early seasons it appears about the first of May, but usually not until the last of that month. The moth into which this larva develops is of a yellowish color about an inch and a quarter across the wings. Upon the light yellow ground of the wings there are two more or less irregular and broken dusky bands crossing the first pair, one of which also extends across the hind wings, and rarely both bands are found on both wings.

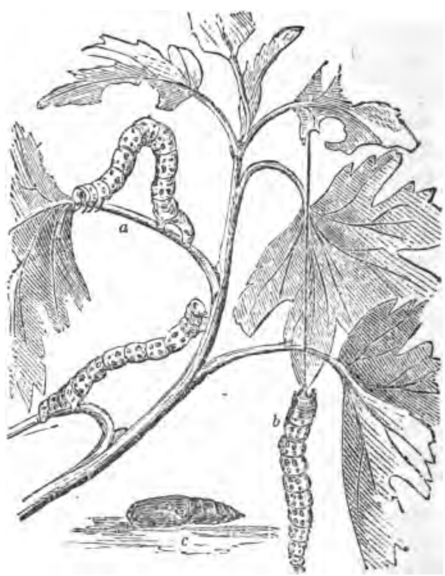


FIGURE 5. *Diastictus ribearia*.
a. and *b.* Larva in different positions. *c.* Chrysalis.

These bands vary a good deal in size and distinctness. The moths are found flying in June or early in July and lay the eggs on the twigs of currant bushes, where they remain until the following spring before they hatch. The larvæ may be removed from the bushes by hand, or if they are nearly mature and

the bushes are shaken they will let themselves drop by a thread of silk, and if a small branch is moved about under the bush they may be drawn to one part of the ground and crushed. Hellebore will destroy some, but it is not so efficient in case of this larva as it is against the saw fly larva, a stronger poison being needed.

FIGURE 6. *A. a.* Larvæ of *Nematus ventricosus.* *b.* portion of the surface magnified.

The other common currant worm is the saw fly larva, *Nematus ventricosus*, Klug, Figure 6. This is a bristly worm, when first hatched of a light color, but when mature it becomes greenish, with a dark head and the surface of the body is spotted with black as seen in Figure 6, b. When full grown the worm makes cocoons of a brownish color from which the flies come in June or early July. The adults, Figure 7, are wasp-like, or bee-like saw flies. The female, as the figure shows, is much larger than the male and much lighter color which is chiefly yellow, while the males are mostly black with yellow spots above and yellow beneath. Soon after leaving the pupa, the females lay their eggs for a second brood which reach their pupa stage during the season and from these pupæ, which last all winter, the spring brood of flies comes. There is a native species which is found on wild currants and gooseberries that figured above being a European insect. The native species, *Pristiphora grossultariae*, Walsh, feeds on the wild currant and gooseberry as well as on garden varieties. In some places it is a serious pest. As its habits are similar to those of the imported species the same remedies are to be used in both cases.

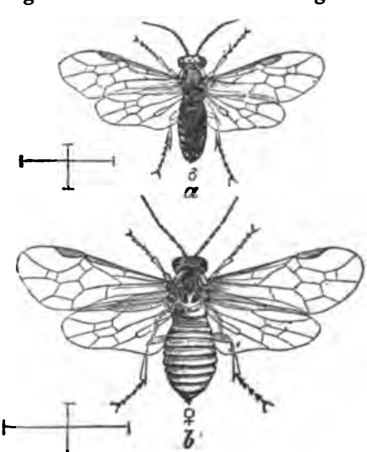


FIGURE 7. *Nematus ventricosus.* Upper figure, Male; lower figure, Female. Both enlarged about three times.

Hellebore is more efficacious when used against the saw fly larva than it is in case of the measuring worm mentioned above, and it is perhaps as valuable a remedy as there is. It may be used dry sprinkled over the leaves or better mixed with water in the proportion of one ounce to two gallons.

A writer in *Insect Life* says that after sprinkling infested bushes he dusted over the leaves a mixture of two parts of unslacked lime and one part of tobacco dust, and that this killed every worm, a single application being sufficient. Kerosene emulsion has been found effective. Simple hot water, but not hot enough to injure the foliage, will cause the larvæ to fall to the ground. Strong brine has been used successfully, but it is open to the objection that unless soon followed by clear water it injures the foliage. Toads are very useful in devouring such worms as fall to the ground or are upon the lower branches, a single toad eating a great number in a short time. Several parasitic and predaceous insects also attack the currant worms.

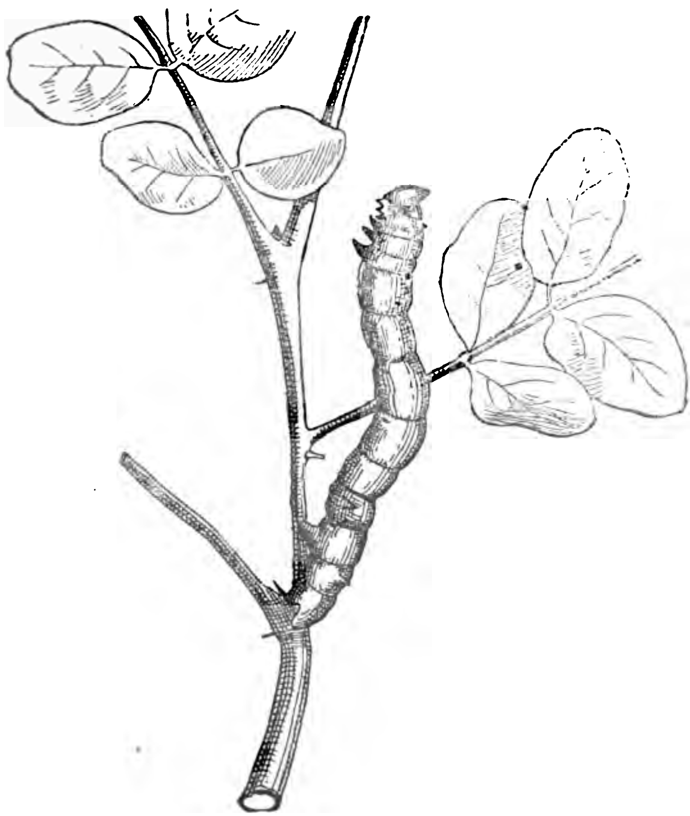


FIGURE 8. Larva of *Biston cognitaria*, somewhat enlarged.

Besides the three chief enemies of the currant, or four if, as we should, we add the native saw fly, there are sundry other species which ordinarily do less damage, but most of them now and then appear in such unusual numbers that they equal in destructiveness the more commonly observed pests.

One of these is, like the *Diastictis* mentioned, a measuring worm found upon the elm and other plants, but it appears to be especially fond of the leaves of the currant. The larva is a brownish or greenish worm much larger than those mentioned being, when full grown, about two inches long, and it has a singular habit, as shown in Figure 8, of attaching itself to a leaf or stem by its hind legs and stretching itself out so that it is not unlike a twig. In the figure it is shown feeding on the Honey Locust and the figure is taken from a Report by Dr. Lintner. The general color, as noticed, is "brown with a greenish tinge, somewhat bluish laterally and on the last segment." The head is dull yellow, while the legs are dull red. The moth, Figure 9, of this species *Biston cognitaria*, Guen (better known as *Amphidasys cognitaria* of authors) is readily recognized when once known by its pepper and salt markings, the general colors being black and white. It is shown natural size in the figure and is about two inches across the spread wings. The larva, when mature, goes into the ground for its pupation. There are two broods each season. This species, fortunately, does not confine itself to one or even a few plants in its feeding. If it did it would be a serious pest, but as it seems equally satisfied upon quite a number of trees and shrubs it is not usually found very abundantly upon any one. Yet it does sometimes strip currant bushes wholly of the leaves. It may, on account of its size, be easily removed by hand-picking, or it may be jarred from the branches to the ground, or of course, hellebore, Paris green or kerosene emulsion would destroy it.

FIGURE 9. *Biston cognitaria*, moth.

The larva of one of our common butterflies *Polygonia progne*, Fab. (Grapta progne Fab.) sometimes found on currant bushes, is light yellow in general color, the head red or reddish. On the body are white branching spines with black tips.

The butterfly (Figure 10,) is a dark brownish orange, spotted and shaded with black with fine white spots. The under side is curiously variegated with black, white, gray and brown.

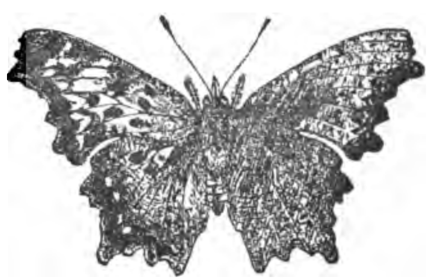


FIGURE 10. *Polygonia progne*, natural size.

The oyster-shell bark louse, an aphis and a small beetle, the larva of which bores the stem, sometimes injure the leaves or stem.

EXPERIMENTS IN BEE KEEPING.

At a regular meeting of the Vermont Bee Keepers' Association held at Burlington, December, 1892, a committee consisting of O. J. Lowrey, of Jericho, M. F. Cram, of Brookfield, and H. W. Scott, of Barre, was appointed to ask the Experiment Station Board of Control to institute experimental work with bees. The requests of the Association having been granted, so far as the funds at hand warranted, the committee recommended that a bee house be built, divided into store room, work and implement room, and apiary room for twenty-four colonies of bees; that a row of evergreens be set upon the north, east and south sides of the house, so as to form a yard in which to place the double-walled hives; and that a Cowan Reversible Honey Extractor, honey knives, brood boxes, clamps, observation hives, queen nursery, etc., be bought.

The bee house was completed and ready for experimental work in the summer of 1893. It was placed in the charge of Mr. T. H. Wheatley, of Brookfield, who was later succeeded by Mr. C. W. Fisher, of Cabot. During September five colonies of bees, donated by members of the Association, were added to the ten already on hand, making fifteen to go into winter quarters in November, 1893. Ten of these colonies were packed with sawdust and cut hay in the house apiary, while five colonies were packed outside in double walled hives. The latter five colonies were packed around the brood nest and on top in the same manner as those in the house, except the packing on top was poured on loose, while in the house this packing was in sacks thoroughly spread out over the entire brood nest. Two colonies more were donated in the spring of 1894, making seventeen in all. Eleven colonies were in the house apiary, eight of which were strong, one medium and two very light; while of the six colonies kept out of doors, one was strong, four medium and one very light.

The following experiments, arranged by the Committee, and approved by by the Board of Control, were carried out:

(1) The bees having come from different sources were on different sized frames. A good opportunity was thus offered for determining the best frame to adopt in the production of comb or extracted honey, as well as for ascertaining the relative values of the different frames for wintering and building up in the spring. No perceptible difference was noted in the different sized frames used in the past season. Since the secretion of nectar is decidedly affected by varying seasons and temperatures, it is evident that experiments

of this kind must extend over a period of years before definite conclusions can be safely drawn.

(2) After the frosts came, when there was no chance for the bees to gather anything outside, sugar syrup was fed to note whether the bees could change the cane sugar into honey sugar. Two colonies of equal strength were chosen, their combs were removed and dry combs placed in their hives. The syrup was made by dissolving twenty pounds of granulated sugar in ten pounds of boiling water. One colony was fed twenty pounds daily for two days, and the other three pounds daily for two weeks. Five samples were taken, the descriptions and analyses of which are shown below.

No. I.—Pure sugar syrup.

No. II.—Honey made from sugar syrup fed at the rate of twenty pounds per day and extracted before being sealed by the bees.

No. III.—Honey made from sugar syrup fed at the rate of twenty pounds per day and extracted after being sealed by the bees.

No. IV.—Honey made from sugar syrup fed at the rate of three pounds per day and extracted before being sealed by the bees.

No. V.—Honey made from sugar syrup fed at the rate of three pounds per day and extracted after being sealed by the bees.

The analysis given under the heading "A" is the average of fifteen samples of genuine honey; that given under the heading "B" is the average of several honeys known to have been adulterated with cane sugar.

	I	II	III	IV	V	A	B
Specific Gravity	1.314	1.400	1.445	1.420	1.417	......	......
Water	35.7	23.7	20.1	21.3	20.9	18.0	19.5
Sucrose, (cane sugar)	61.6	24.2	30.0	19.0	17.1	2.8	11.8
Laevulose, (honey sugar)	2.7	50.9	50.4	60.2	6.3	7.1	58.8
Ash	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Albuminoids	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Acidity (as formic acid)	0.12	0.037	0.037	0.037	0.033	......	......
Polarization, (before inversion)	60.8	15.8	24.6	8.6	8.0	—0.2	16.0
Polarization, (after inversion)	—10.5	—8.0	—6.9	—8.3	—7.3	—12.9	—14.0

Nos. I, II and III did not granulate, while Nos. IV and V granulated.

If these honeys had been sold in open market, and had been sampled and analyzed, Nos. II and III would surely have been condemned as adulterated with cane sugar, while Nos. IV and V would probably have been condemned also. The polarizations before inversion of Nos. IV and V did not largely exceed those hitherto found with pine tree honey. The amount of sucrose, however, is greater than has been found in any honey of known purity. Few honeys other than those made from pine trees have been found to polarize before inversion to the right. It is safe to say that normal honey polarizes to the left ninety-nine times in a hundred. Apparently the bees partially but not

entirely changed the cane sugar into honey sugar in this experiment, eliminated much of the water and added an acid (probably formic acid), to the honey, before capping. The differences in weights of the various honeys are not marked. It is evident from the experiment that to prevent the honey from granulating in fall feeding it is better to feed rapidly; yet slow feeding is apt to stimulate brood rearing, which is not desirable in the late fall with bees in our northern climate. The intelligent apiarist will keep his bees from sugar syrup during the honey flow, and will use every precaution to prevent adulteration of his comb or extracted honey, not only because it is contrary to the laws of our State, (which impose a fine upon adulteriation of bees' honey, No. 52, Acts of 1890,) but because it is right.

(3) Stimulative feeding, during the spring, received its share of attention. It is a great advantage to the bee keeper to have a large force of field bees at the opening of the white honey blossom. Since it takes twenty-one days under normal conditions for the egg of the worker to become fully developed as a bee, and from ten to fourteen days more before this young bee enters the field to gather honey, it will be seen how necessary it is to have the queen of each colony doing her best egg laying, thirty or thirty-five days before the contemplated honey flow.

An experiment was made in stimulative feeding in the spring. Four colonies of bees were selected. Two colonies, one strong and one weak were fed on diluted honey at the rate of one-half pound each day, and two other colonies of equal strength were fed sugar syrup at the same rate. This feeding was commenced May 1st and continued for two weeks. Owing to one light colony being robbed during the second week and, also to the steady flow of new honey coming from willow, soft maple and elm, no perceptible difference could be noticed with colonies of equal strength, and the experiment was abandoned for the season. This experiment should be continued another season since stimulative feeding in the early spring may be of benefit in securing a large working force of bees and thus increasing the yield of honey per colony.

(4) A thorough trial was made of the Langdon non-swarmer with four colonies of bees. Such an appliance, if properly constructed and used, might prove of great value to the honey producers of the State. This particular apparatus, however, has proved a failure so far as preventing any desire to swarm. Two strong colonies running together with a non-swarmer, proved unequal in the production of comb honey to single colonies that were allowed to swarm at will. The non-swarmers were placed in front of the hives May 30, and changed every few days as the following table will show. Numbers three and four and numbers six and seven were run together.

LANGDON NON-SWARMING EXPERIMENT, MADE AT APIARY IN 1894.

Date Changed.	Nos. 3 and 6.	Nos. 4 and 7.	Remarks.
May 30	Cases on these.	....	All heavy colonies, not many eggs in brood combs.
June 7	....	Cases changed to these..	....
June 11	Put on these...	....	....
June 16	....	Put on these...........	Nos. 3 and 6 well drained, one queen.
June 20	Put on these...	....	All cut out of No. 3. Not as many eggs in No. 6 as in No. 3.
June 23	....	Put on these...........	No. 4 had 12 capped cells.
June 28	Put on these...	....	No. 3 had 4 capped cells
July 2	....	Put on these...........	Very few eggs in Nos. 4 and 7.
July 6	Put on these...	....	No. 3 had eight cells torn down.
July 10	....	Put on these...........	....
July 15	Put on these...	....	No. 4 had no eggs.
July 20	....	Put on these...........	....
July 25	Put on these...	....	....
July 30	....	Put on these...........	....

August 4th the non-swarmers were removed. Numbers three and four were found to be queenless, while numbers six and seven had brood and eggs. The colonies used in this experiment were strong, doing if anything better than the average. The amount of honey obtained from numbers three and four was 41 pounds, from numbers six and seven, 64 pounds. The average from fourteen colonies was 46½ pounds, counting in numbers three and four, six and seven as four colonies, leaving six and four out, the average for the other ten was $54\frac{6}{10}$ pounds per colony. Some of our heavy colonies allowed to swarm at will made seventy-five pounds of section honey.

(5) Each bee hive in the Experiment Station Apiary is situated on the east side of the bee house in a room 6x24 feet. This room is arranged with two rows of shelves, the upper shelf at a suitable distance above the lower one to admit of easy manipulation of the bees, there being room for twelve colonies on each shelf. Suitable light is obtained from eight windows. The temperatures of this room during some of the coldest days in February and March, 1894, are given in the table below.

					Outside.	In bee room.
Feb. 5, very cold and windy, at	7	oclock A. M.	thermometer		—10°	0°
" "	12	"	"		10°	36°
" 6 "	7	"	"		—3°	5°
" "	12	"	"		17°	35°
" 25 "	7	"	"		—18°	10°
" "	12	"	"		1°	24°

After this date the temperature of the brood nest was taken by placing a thermometer on top of the frames over the center of the cluster.

					No. 5.		No. 6.		No. 9.		No. 10.	
February.....	7 a.m.	12 m.	7 a.m.	12 m.	7 a. m.	12 m.	7 a.m.	12 m.	7 a.m.	12 m.	7 a.m.	12 m.
" 26	....	20°	....	30°	....	78	....	37	....	82	...	80
" 27	4°	30°	14°	43°	69	74	35	54	72	73	74	80
" 28	27	....	30	....	74	....	46	....	78	....	78	....
March ... 2	40	...	40	....	74	....	56	....	70	....	....	...
" 5	....	50	....	53	...	76	....	60	....	70	....	70
" 18	....	....	....	54	....	75	....	65	..	66	....	....
" 27	8	23	13	30	38	50	34	41	40	42	42	45

Numbers five and nine were lighter in bees than six and ten, which may account somewhat for some of the variation of temperature, but as all these colonies wintered and built up strong the following spring, the experiment seems to show that temperatures may vary without detriment to the bees. If there is no moisture in the air our bee room is practically dry, no frost at any time having been seen upon the walls. Successful wintering of bees needs the careful attention of the bee keeper especially during the months of February and March.

Experiments along these and other lines are being carried out during the present year (1895) and the results will be published in the next report.

A word in conclusion on spraying. The horticulturalist, mindful of the necessity of the proper fertilization of his fruit blossoms, should consult his own interests as well as those of the bee keeper, by refraining from spraying his trees during their bloom. It is moreover unnecessary to spray at this time, since it has been shown that the proper season for spraying is immediately after the petals fall.

O. J. LOWREY,
M. F. CRAM,
H. W. SCOTT,
Committee of the Vermont Bee Keepers' Association.

The thanks of the Station are due to Messrs. O. J. Lowrey, M. F. Cram and H. W. Scott, committee, for their valuable assistance in planning the bee house, for advice given during its erection, for the outlining and partial oversight of the experiments, and for the preparation of the above report.

MALLEIN AS A DIAGNOSTIC FOR GLANDERS IN HORSES.

BY F. A. RICH.

In the course of the past year the writer has had several occasions to use the mallein furnished by the Bureau of Animal Industry of the Department of Agriculture at Washington, as a diagnostic for glanders. It has proved very reliable and has been particularly valuable in the detection of obscure cases. The first seven records were made in one locality in the eastern part of the State. Five of the seven animals injected gave reactions. The exposure of the neighborhood had been quite general.

Mallein is used essentially in the same manner as tuberculin (see p. 46 this report) and like that diagnostic is prepared by growing the bacillus or germ of the disease which it detects (in this case, glanders) in a pure culture (growth of one species of germ by itself, all others being excluded) until highly concentrated and until a large amount of its ptomaines are developed. A marked rise of temperature following injection, unaccounted for in other ways, constitutes a reaction.

The results obtained are shown in the following table :

	At injection. °F	Nine hours after injection. °F	Eleven hours after injection. °F	Thirteen hours after injection. °F	Fifteen hours after injection. °F	POSTMORTEM NOTES.
1	100.6	**103.4**	**104.2**	**105.6**	**104.4**	General throughout body.
2	99.8	102.4	**103.6**	**105**	**105**	" " "
3	99.8	**104**	**104.2**	**103.8**	**103**	Throat, lungs, peritoneum.
4	100	99	99.2	100	99.8	Sound, not killed.
5	100.2	98.8	99	99.8	......	" "
6	100.8	**104**	**105.2**	**105.6**	......	General throughout body.
7	100	**103.8**	**105**	**105.2**	......	" " "
8	99	98.6	99.6	99.8	99.4	Sound, not killed.
9	99.6	99.	99.6	99.6	99.8	" "
10	100.7	101	101	100.6	100.6	" "
11	100.7	**104.2**	**104.1**	**105.1**	**105.2**	Peritoneum, mesentery, trachea, lungs and liver.

DAIRYING.

BY J. L. HILLS.

The prominence of dairying in Vermont farm operations has caused the Station for many years to make investigations in that line a very important part of its work. The experiments completed within the year in dairy lines, (taking the word in its widest sense, to include not only the care and handling of cows, milk and butter, but also crop raising, harvesting and preservation) are grouped under the headings given below. Owing to the slaughter of the station herd early in the year as noted on pages 21-29 of this report, and the several months elapsing before the present herd was established, the "herd record" for milk and butter, which has been a feature of the preceding reports cannot be given for 1894.

I.—Feeding Tests.
   1. Robertson Mixture vs. Corn Ensilage.
   2. Robertson Mixture and Corn Ensilage vs. Beets and Carrots.
   3. "Nutriotone," a Condimental Food.

II.—Tests of Dairy Apparatus.

III.—The Lactanalyt, a new Milk Tester.

IV.—The Effect of Fatigue upon the Quality and Quantity of Milk.

V.—Earl of Montague, 25,009 A. J. C. C.

VI.—Miscellaneous Fodder Crops.

VII.—Four Methods of Preserving Fodder Corn.
   1. Results of Preservation.
   2. Results of Feeding.
   3. Records of the Test.

I. FEEDING TESTS.

1. ROBERTSON MIXTURE VS. CORN ENSILAGE.

The last report of this Station contained an account of a feeding experiment designed to test the relative values of corn ensilage and the so-called "Robertson mixture" (corn ensilage, horse beans and sunflower heads) as cattle foods. The slaughter of a portion of the Station herd because of

tuberculosis, the removal of the survivors to other quarters and necessary changes in feeding brought in so many disturbing factors that the results were of doubtful value and the test was repeated.

The corn plant is deficient in protein, and, to some extent, in fat. A balanced ration cannot be made from it alone. The usual method of making good the deficiency is to feed more or less largely of bran, cottonseed, linseed or gluten meals. These, however, draw money from the farm, although adding fertility to it, if the manure is properly handled. "Home grown protein" is therefore desirable, since it may cost less than that which is bought. Clovers, peas, beans, vetches, etc., have been used for the purpose with considerable success. A promising source of home grown protein was proposed a few years ago by Prof. Jas. W. Robertson, Dairy Commissioner of Canada, who advised cutting into the silo a mixture of corn, horse beans (whole plant) and sunflower heads, in the proportion of ten, three and one and a half tons respectively.

The horse bean (*Faba vulgaris, var. equina*) is a leguminous plant, a "nitrogen gatherer," containing from two to two and a half times as much protein as corn. The sunflower (*Helianthus annuus*) heads contain large amounts of oil, thus increasing the amount of this ingredient in the ensilage. It is claimed that as good results are obtained with four pounds less grain per fifty pounds of ensilage when thus mixed with the horse beans and sunflower heads.

At harvest in 1894 a silo was filled with the Robertson mixture, the ingredients being mixed in the proportions stated by its originator. Owing to the dry weather, the stand of the horse beans was poor. In order to get enough for a feeding test we had to use in addition the crop from two tenths of an acre of soja beans. The soja bean (*Soja hispida*) is also a leguminous plant, but contained last year considerable less protein than the horse bean, although previous growths at this Station have been as rich in this ingredient as the horse bean. The stand of sunflowers was also inferior because of the prolonged drought; in fact, all crops suffered exceedingly.

Silo No. 3 was partitioned perpendicularly, the Robertson mixture cut into one side, and Sanford corn from the same field into the other side. Both had other non-experimental ensilages above and below them, separated by layers of boards. There were quite large losses, however, as this silo, although repaired, never has kept ensilage successfully. It was the only one available, however, for this work.

The amounts put in and taken out were as follows:

Corn ensilage: put in, 15,620 pounds; taken out, 11,447 pounds good and 1,553 pounds poor ensilage. Robertson mixture ensilage: put in, 17,490 pounds; taken out, 12,235 pounds good and 2,511 pounds poor ensilage.

The fodders were sampled as put into the silo and the ensilage as taken out in the same manner as that described in the article in this report on "Four Ways of Preserving Fodder Corn."

ANALYSES OF ENSILAGE AND LOSSES IN THE SILO.

The following tables show analyses of the various materials at harvest and as fed, together with a statement of the losses in ensilaging. The spoiled ensilages are not included and consequently appear in the lost columns.

AVERAGE ANALYSES AS HARVESTED AND AS FED.

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Corn ensilage, as harvested	75.75	24.25	6.50	7.87	20.00	62.51	3.12	1.260	0.356	1.401
Corn ensilage, as fed	76.05	23.95	8.55	8.60	25.37	54.95	2.53	1.376	0.372	1.485
Corn for Robertson mixture	76.72	23.28	7.70	7.96	20.10	61.09	3.15	1.274	0.329	1.393
Horse beans for Robertson mixture	82.47	17.53	10.95	22.73	18.75	44.11	3.46	3.637	0.749	2.055
Soja bean (black) for Robertson mixt.	68.38	31.62	7.56	13.68	23.10	51.72	3.94	2.184	0.561	2.282
Soja bean (green) for Robertson mixt.	69.88	30.12	7.95	11.35	23.88	52.75	4.07	1.815	0.504	1.985
Sunflower heads for Robertson mixture	86.26	13.74	9.23	11.41	18.96	53.71	6.69	1.827	0.789	2.929
*Robertson mixture as put in	78.19	21.81	8.20	‡13.12	19.15	57.19	3.95	2.100	0.487	1.860
†Robertson mixture as put in	78.21	21.79	8.31	10.66	20.08	57.40	3.64	1.701	0.431	1.599
Robertson mixture as fed	79.34	20.66	10.52	11.88	24.86	49.49	3.25	1.901	0.443	1.984

*Direct analysis.

†Calculation from analyses of its various components in the proportions used.

‡This fig re is probably incorrect. The analysis was verified, however, and the only explanation we can give is that in some way ammonia or something akin to it found access to the samples.

LOSSES OF FOOD INGREDIENTS IN THE SILO.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
CORN ENSILAGE.											
As put in	15,620	11832.1	3787.9	246.2	298.1	757.6	2367.8	118.2	47.7	13.5	53.1
As fed	11,447	8705.7	2741.3	234.4	235.7	695.6	1506.3	69.3	37.7	10.2	40.7
Losses	4,173	3126.4	1046.6	11.8	62.4	62.0	861.5	49.9	10.0	3.3	12.4
Percent losses	26.7	26.4	27.6	4.8	20.9	8.2	36.4	42.3	20.9	24.4	23.3
ROBERTSON MIXTURE ENSILAGE											
As put in	17,490	13675.4	3814.6	317.0	406.6	766.0	2189.6	138.9	65.1	16.4	61.0
As fed	12,236	9707.9	2528.1	265.9	300.2	628.6	1251.2	82.2	48.1	11.2	50.2
Losses	5,254	3967.5	1286.5	51.1	106.4	137.4	938.4	56.7	17.0	5.2	10.8
Percent losses	30.0	29.0	33.7	16.1	26.1	17.9	42.8	40.8	26.1	31.7	17.7

The losses are excessive, greater than should occur in a good silo. As usual they fall mainly upon the more soluble carbohydrates. The losses of dry matter exceed proportionally the losses in total weight.

Six cows were selected for the feeding experiment, which lasted for sixteen weeks, of four four-weeks periods.

COWS USED IN THE EXPERIMENT.

GROUP C.	Age.	Calved.	Served.	Live weight at beginning of test.
Eulalie	6	Oct. 11.	March 3.	898
Rhoda	6	Sept. —	Oct. 23.	843
Flora	6	April 15.	Nov. 26.	775
GROUP D.				
Portelette	7	Sept. —	Feb. 23.	764
Lady Le Brocq	6	Sept. —	Feb. 20.	718
Bettie	7	May 5.	Dec. 11.	832

FEEDING PERIODS AND FODDERS FED EACH GROUP.

Period Number.	Dates of Period.	Group C.	Group D.
I.	Nov. 26-Dec. 24.	Corn ensilage.	Robertson mixture.
II.	Dec. 24-Jan. 21.	Robertson mixture.	Corn Ensilage.
III.	Jan. 21-Feb. 18.	Corn ensilage.	Robertson mixture.
IV.	Feb. 18-Mar. 18.	Robertson mixture.	Corn ensilage.

Milk samples were taken in the same manner as that described in the article in this Report on "Four Ways of Preserving Fodder Corn."

WEIGHTS OF COWS.

The cows were weighed on three successive days of the opening period and on the three closing days of each period while under experiment. The average weights were as follows:

NAME OF COW.	I.	I.	II.	III.	IV.
Eulalie	898	883	875	873	898
Rhoda	843	823	842	846	862
Flora	775	779	790	782	783
Portelette	765	746	738	768	773
Lady Le Brocq	718	703	684	713	717
Bettie	832	820	812	832	852

Two cows closed the test weighing the same, or a little more, than at the opening. All except Flora, dropped off a little in weight during the midwinter, regaining it again, however, in the early spring.

YIELDS AND QUALITY OF MILK.

Each of the ten cows were fed ten pounds daily of fine early cut hay. While on corn ensilage they received four pounds bran and four pounds corn meal daily; while on the Robertson mixture, two pounds grain less for every fifty pounds of ensilage fed. Prof. Robertson states that as good results will be obtained with four pounds less grain per fifty pounds of ensilage fed, but on account of lower fat and protein contents of the mixture than contemplated by its originator, but two pounds less were fed. During the sixteen weeks each cow had eight weeks feeding on each fodder, so that there were equal numbers of days feeding equally distributed, the equivalent of 336 days feed for one cow. The following table shows the total yields and quality of the milk given for the last eighteen days of all the periods (which alone were considered experimental) equivalent to 216 days feed for one cow.

	Milk. lbs.	Total Solids. per ct.	Fat. per ct.	Solids not fat. per ct.	Total Solids. lbs.	Fat. lbs.	Solids not fat. lbs.
Corn ensilage..........	4,007	14.32	5.04	9.28	574	202	372
Robertson mixture......	3,978	14.50	5.15	9.35	577	205	372

Essentially the same amounts of milk and butter were given with the Robertson mixture ration with two pounds less grain per 50 pounds of ensilage as with the corn ensilage ration. The difference in quality of the milk was too slight to lay stress upon.

AMOUNT EATEN BY THE COWS.

The Robertson mixture was not eaten as readily as the corn ensilage by any of the cows, there being a fifth less dry matter consumed from the experimental fodder, as well as less grain eaten. The amounts of hay, grain and experimental ensilages eaten during the eighteen day experimental periods were:

By cows when on corn ensilage; 2,169 pounds hay, 864 pounds corn meal 864 pounds bran (containing 3,374 pounds of dry matter) and 5,486 pounds ensilage (containing 1261.5 pounds of dry matter,) making a total of 4,636 pounds of dry matter.

By cows while on Robertson mixture; 2,160 pounds of hay, 681½ pounds of corn meal, 681½ pounds of bran (containing 3,058 pounds of dry matter) and 5,014 pounds of Robertson mixture (containing 1004.3 pounds of dry matter,) making a total of 4,062 pounds of dry matter.

The hay and grain, except as the latter was cut down during mixture feeding, was equally distributed among periods and cows. The following

table shows the amounts of total dry matter eaten, that derived from the experimental ensilage and the average of each eaten daily per cow during experimental periods.

DRY MATTER EATEN.

KIND OF ENSILAGE.	InE re Ration. lbs.	Average Amount daily per Cow. lbs.	In Experimental Fodder. lbs.	Average Amount daily per Cow. lbs.
Corn ensilage	4,636	21.5	1,262	5.84
Robertson mixture	4,062	18.8	1,004	4.65

RELATIVE YIELDS FROM EQUAL AMOUNTS OF DRY MATTER IN ENTIRE RATION AND IN EXPERIMENTAL ENSILAGES.

Combining the data of the last two tables we have the direct comparison of the efficiency of the two ensilages.

	YIELD PRODUCED FOR EACH 100 POUNDS OF DRY MATTER.			
	Milk.	Total Solids.	Fat.	Solids, Not Fat.
IN ENTIRE RATION.				
Corn ensilage	86.4	12.38	4.35	8.03
Robertson mixture	97.9	14.20	5.05	9.15
IN EXPERIMENTAL ENSILAGE.				
Corn ensilage	317.5	45.49	16 00	29.49
Robertson mixture	396 2	57 47	20.42	37.05

The balance is strongly in favor of the Robertson mixture, more milk and butter being produced than from similar weights of dry matter in corn ensilage. The cows, if anything, gained in weight on the mixture. It seems that in this test at any rate the claims made for the mixture are not without basis.

Notwithstanding the favorable results in this trial, the writer does not feel as yet like recommending the mixture to the Vermont dairyman. We have not thus far been able to grow horse beans successfully. We have grown them for two years, but neither time have had a satisfactory stand, although the soil conditions seemed favorable. A blight turning the pods and leaves black

caused much trouble. Similar troubles have been reported elsewhere in New England. In Canada, however, there have been several cases of luxuriant growth. Where this can be obtained, it is not unlikely that this mixture will prove profitable.

RECORDS OF THE COWS INDIVIDUALLY DURING THE EXPERIMENT.

NAME OF COW.	Number of Period.	Experimental Fodder.	Preliminary Period.		Experimental Period.						To 100 pounds of Dry Matter in Experimental Fodders, there was given.		
			Dry Matter Eaten.	Milk Given.	Dry Matter Eaten.	Milk Given.	Total Solids.	Fat.	Total Solids.	Fat	Milk.	Total Solids.	Fat.
			lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.
Eulalie	I.	C. E.	71.9	223.4	144.6	378.6	13.72	4.62	51.95	17.49	261.8	35.92	12.09
	II.	R. M.	32.7	231.5	105.0	455.0	14.42	4.91	65.60	22.35	433.0	62.47	21.28
	III.	C. E.	51.3	224.8	87.8	402.1	14.09	4.79	56.65	19.27	457.8	64.52	21.95
	IV.	R. M.	49.8	217.9	92.7	422.8	14.53	5.04	61.45	21.33	451.8	66.29	23.01
Rhoda	I.	C. E.	54.2	179.3	93.7	312.9	14.13	4.93	44.22	15.44	333.9	47.19	16.48
	II.	R. M.	19.9	174.1	47.1	351.6	14.29	4.92	50.26	17.32	746.5	106.71	36.77
	III.	C. E.	45.9	180.9	59.1	312.5	13.83	4.78	43.21	14.93	528.7	73.11	25.26
	IV.	R. M.	36 0	167.1	72.0	292.2	14.92	5.30	43.61	15.49	400.3	60.57	21.51
Flora	I.	C. E.	65.6	134.7	144.5	281.0	15.31	5.96	43.16	16.81	195.1	29.87	11.63
	II.	R. M.	41.2	163.0	88.6	334.7	15.31	5.93	51.23	19.83	377.7	57.82	22.38
	III.	C. E.	70.0	179.9	105.0	314.9	15.08	5.74	47.50	18.08	299.9	45.24	17.22
	IV.	R. M.	50.8	160.7	86.2	282.9	15.62	6.20	44.20	17.49	328.2	51.28	20.29
Portelette	I.	C. E.	47.0	201.9	78.1	342.8	13.31	4.44	45.63	15.22	438.9	58.42	19.49
	II.	R. M.	61.0	195.4	120.2	374.2	13.72	4.55	51.35	17.03	311.3	42.72	14.17
	III.	C. E.	32.3	211.3	56.5	394.3	13.48	4.29	53.15	16.93	697.8	94.07	29.96
	IV.	R. M.	56.8	209.2	101.8	403.5	13.45	4.29	54.28	17.33	396.3	53.32	17.02
Lady Le Brocq	I.	C. E.	64.6	169.2	109.2	285.4	14.54	5.35	41.50	15.26	261.3	38.00	13.97
	II.	R. M.	50.6	182.7	99.2	362.6	15.01	5.43	54.44	19.79	365.5	54.88	19.95
	III.	C. E.	35.1	179.	73.8	336.3	14.97	5.39	50·35	18.14	455.7	68.22	24.58
	IV.	R. M.	58.7	176.6	92.4	327.0	15.38	5.81	50.30	18.99	352.9	54.44	20 55
Bettie	I.	C. E.	60.4	125.1	98.7	219.3	14.53	5.41	31.37	11.86	222.2	32.28	12.02
	II.	R. M.	60.9	140.2	114.6	265.7	14.28	4.95	37.95	13.16	231.8	33.11	11.48
	III.	C. E.	42.9	139.3	96.4	260.2	14.55	5.23	37.87	13.61	269.9	39.28	14.12
	IV.	R. M.	64.1	136.7	98.6	271.4	14.47	5.15	39.26	13.98	275.2	39.82	14.18

2.—ROBERTSON MIXTURE AND CORN ENSILAGE VS. ROOTS.

There were a few beets and carrots available for feeding at the end of the experiment just described. The six cows used therein were, at its close, fed two weeks on the ensilages together with 10 pounds hay and 6¾ or 8 pounds of equal parts bran and corn. They were then put gradually upon a full feed of cut beets and carrots, the change taking about one week, and were then fed daily the usual amount of hay (10 pounds), corn meal and bran (6¾ pounds) and 45 pounds of mixed cut roots for two weeks when the supply of the latter ran out. The cows were fed as nearly as might be equal quantities of dry matter in the ensilage and root rations. They left but few orts from the roots, and so ate considerably more dry matter in the root ration.

The analyses of the Robertson mixture, corn ensilage, beets and carrots and the results of the feeding are shown in the following tables:

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Robertson Mix.	80.30	19.70	9.58	10.98	26.56	49.13	3.75	1.757	0.412	1.305
Corn Ensilage..	78 55	21.45	10.02	7.96	27.08	52.42	2.52	1.274	.....	.....
Carrots........	84.99	15.01	11.70	10.76	1.66	72.18	3.70	1.722	.....	.....
Beets....	85 43	14.57	14.66	10.32	6.93	67.09	1.00	1.651	.....	.....

	Experimental fodder.	Preliminary Period.		Experimental Period.						To 100 lbs. of dry matter in experimental fodders, there were given		
		Dry Matter Eaten.	Milk Given.	Dry Matter Eaten.	Milk Given.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.
		lbs.	lbs.	lbs.	lbs.	%.	%.	lbs.	lbs.	lbs.	lbs.	lbs.
Eulalie	C. E.,	......	......	77.7	333.5	14.45	5.08	48.21	16.93	429.2	62.0	21.6
	Roots,	45.8	163.2	89.3	320.2	14.67	5.20	46.97	16.66	358.5	52.6	18.7
Rhoda................	C. E.,	......	......	57.9	225.9	14.94	5.39	33.65	12.17	390.1	58.1	21.0
	Roots,	40.5	112.5	83.0	213.5	15.21	5.36	32.47	11.46	257.2	39.1	13.8
Flora................	C. E.,	......	......	63.3	230.7	15.00	5.79	34.57	13.35	364.4	56.2	21.0
	Roots,	39.6	119.3	81.4	244.7	15.19	5.80	37.16	14.20	300.6	45.6	17.4
Portelette............	R. M.,	......	......	65.8	327.5	13.49	4.38	44.18	14.35	497.7	67.1	21.8
	Roots,	42.1	166.8	82.0	307.2	13.75	4.53	42.26	13.92	374.6	51.5	16.9
Lady Le Brocq........	R. M.,	......	......	58.7	260.2	15.12	5.76	39.35	15.00	443.2	67.0	25.6
	Roots,	41.1	133.7	79.5	260.2	15.54	5.71	40.45	14.85	327.3	50.9	18.7
Bettie................	R. M.,	......	......	71.7	219.0	14.36	5.16	31.46	11.29	304.6	43.7	15.7
	Roots,	44.7	113.8	85.3	216.7	14.97	5.32	32.44	11.53	254.0	48.0	13.5
Three Cows...........	C. E.,	......	......	198.9	790.1	14.73	5.38	116.4	42.5	397.0	58.5	21.4
	Roots,	125.9	385.0	253.7	778.4	14.97	5.43	116.6	42.3	306.8	45.9	16.6
Three Cows...........	R. M.,	......	......	196.4	806.7	14.25	5.03	115.0	40.6	410.7	58.6	20.7
	Roots,	127.9	414.3	246.8	784.1	14.69	5.13	115.2	40.3	317.7	46.6	16.3
All Cows.............	Ens'l'g.,	......	......	395	1597	14.46	5.19	231.4	83.1	404.3	58.5	21.0
	Roots.	253	809	501	1563	14.84	5.31	231.8	82.6	311.9	46.3	16.5

If we were only to consider the data in the columns showing yields per hundred pounds dry matter in experimental fodders, the results would be decidedly against the roots. These columns, however, give an exaggerated comparison which is faulty when there are many more orts left from one class of fodder than from another, as in the present case. The dry matter of the roots made

up about 33 per cent of the entire ration, while that of the ensilages made up but about 28 per cent, although the two classes of roughages were fed so as to put as nearly as might be equal quantities of dry matter into the mangers.

The table shows that three weeks later in lactation six cows gave the same weight of total solids and fat, and 98 per cent as much milk on a ration one-third of the dry matter of which was derived from beets and carrots as they did on a ration containing two-sevenths of its dry matter in the form of either Robertson mixture or corn ensilage. Or, stating the matter in another way, as much total solids and fat and nearly as much milk were made three weeks later in lactation on the root ration, but at the expense of about 8 per cent more dry matter. The quality of the milk given on beets was quite different from that given on the ensilage ration, the variation being in the solids not fat. The nature of this variation is different from that usually observed when milk changes in quality. The table shows the same relative results with each ensilage when compared with the roots.

On the whole, the results appear to be about even. We do not feel like laying stress upon them however because of the short duration of the trial. An extended test of corn ensilage and roots is planned for the coming winter.

3. "NUTRIOTONE," A CONDIMENTAL FOOD.

The following experiment was not made at this station, but was carefully carried out and placed at our disposal by Mr. J. G. A. Kullander, a former member of the Station staff. Proper precautions were used and the test was made under such circumstances as cause it to be entirely trustworthy. The feeding periods might have been longer with advantage; otherwise we have nothing to criticise in the conduct of the test. Seven registered Jersey cows, all calving in the fall or early winter, were fed a daily ration of fifteen pounds mixed hay, three pounds each of bran and corn, two pounds each of oats and gluten meal and one pound of malt sprouts throughout the test, which lasted from January 24 to April 3, or ten weeks, divided into five two week periods. During the first, third and fifth two week periods two tablespoonfulls, the prescribed amount of "Nutriotone," a condimental cattle food, largely advertised and sold to some extent in Vermont, was added to the ration, while none whatever was fed during the second two weeks and an equal quantity of linseed meal replaced it in the fourth two weeks. The following table shows the gross yields of milk and fat and the quality of milk for each period.

		Pounds of Milk.	Per cent of Fat.	Pounds of Fat.
Jan. 24-Feb. 6.....	"Nutriotone" fed..... ...	1,554	5.47	84.78
Feb. 20	No "Nutriotone" fed.....	1,566	5.55	86.83
Feb. 21-March 6...	"Nutriotone" fed.........	1,514	5.42	82.02
March 7-20...	Linseed Meal fed..,......	1,531	5.37	82.22
March 21-April 3...	"Nutriotone" fed..... ...	1,449	5.45	78.96

The analysis of "Nutriotone" was given in our last report (p. 27) and the statement made (p. 28) that "its feeding value is but little greater than that of a good quality of wheat bran * * * Such condimental cattle foods were proved by Sir John Lawes to be of no advantage to healthy stock." "Nutriotone" costs, according to the amounts purchased, from $250 to $500 per ton. The circular of the makers states that if two tablespoonfuls are mixed with each grain feed the user "will be agreeably surprised at the increased quantity and improved quality of milk * * and productiveness of the animals."

The material does not appear to have increased production in this particular experiment.

II.—TESTS OF DAIRY APPARATUS.

The fourth session of the Dairy School of the University of Vermont and State Agricultural College was held at Burlington, from January 14 to February 8, 1895. A considerable amount of data was obtained by the Station officers during the course of the school upon the following points.

1. Relative efficiency of different makes of separators.
2. Power consumed by different makes of separators.
3. Character and amonnt of losses in the creamery process, including mechanical losses.
4. Details of churning.

The school was equipped with the best apparatus obtainable. Butter workers, aerators and churns were the same as were used in previous years. There were nine separators in use, five power and four hand.

Separator.	Kind.	Manufacturer or Agent.	Rated Capacity per Hour.
Improved Danish	P	A. H. Reid, 30th and Market Sts., Philadelphia, Pa	2,000
Alpha Acme Belt	P	De Lavel Sep. Co., 74 Courtlandt St., N. Y	2,000
Alpha Turbine	P	" " " "	2,000
Baby Alpha, No. 2	H	" " " "	300
Baby Alpha No. 3	H	" " " "	600
Jumbo	P	Davis & Rankin, Chicago, Ill	2,000
United States "B" No. 1	P	Vt. Farm Machine Co., Bellows Falls, Vt.	2,000
United States, No. 3	H	" " " "	300
United States, No. 5	H	" " " "	600

The machines, with the exception of the Jumbo, were kindly loaned by the manufacturers, to whom the University is greatly indebted for courtesies shown.

The machines were generally run in the presence of and sometimes with the help of the agents of the different companies, and it is fair to suppose that they were run at their best. The power machines were set on a stone pier and run by a 12-horse power engine.

The general method of procedure during the Dairy School was as follows:

The Station farm milk, either two or three milkings, was poured into a milk vat and warmed to the temperature desired, so that the entire mass of the milk remained at the desired temperature for quite a while before it was run through the separator. Uusally but one separator was used, all the milk being run through the one machine and the cream churned by itself, so that the record shows the work and results from each machine separately. On some days, however, two or more machines were used. This renders a small portion of the records somewhat fragmentary.

The cream was caught in cans, run over the cooler, which both aerated it and brought it to any desired temperature. It was then set in the cream vat, sometimes with and sometimes without a starter, usually held for twenty-four hours, with frequent stirring, churned, washed into the granular form, salted on the worker an ounce to the pound, worked thoroughly and printed at once.

Samples and weights of whole milk, skimmilk, separator bowl slop, butter milk and butter were taken every day throughout the test. Generally four samples of each whole milk, six to ten of skim milk, two of buttermilk, and always two of butter were taken and all analyzed.

We thus have the figures for calculating the amount of fat originally present in the milk, the amounts lost in the skim milk, bowl slop, and in the butter milk, the amount recovered in the butter, and that lost mechanically. The following tables give the most important facts concerning the handling of the milk and the cream.

It will be noticed that there was considerable difference in the capacity of the various machines in the amount of milk they can skim per hour, and the average figures for each will be found under the tests of each machine.

The horse power used by the belt separators was measured by means of the Emerson Power Scale, a transmission dynamometer, manufactured by the Emerson Power Scale Co., of Florence, Mass. A comparison of the relative steam consumption of the De Laval Alpha Turbine and the United States, No. 1 B belt separators was also made by Prof. A. W. Ayer, of the Mechanical Department of the University, the results of which form a portion of this article.

For extended tables showing the results of forty-nine different machines of twenty makes, twenty-six tested at this and twenty-three at other stations, the reader is referred to the last (Seventh) report of this station.

Date of Separation.	I. SEPARATOR.	Revolutions per minute.	Pounds of Milk per hour.	Ratio, Cream to Milk.	Per cent of Milk taken as Cream.	Per cent of fat in Whole Milk.	Skim Milk.	Bowl Slop.	Butter Milk.	Butter.	Horse Power used.	Horse Power used per 1000 lbs. Milk per hour.
14	DeLaval Alpha.......	5,670	2,520	6.9	12 8	4.75	0.05	0.25	0.04	82.72	....	....
15	Turbine	5,800	2.473	5.2	16.0	4.88	0.03	0.13	0.11	81.94	....	....
24	....	5.470	2,490	5.6	15.0	4.72	0.06	0.20	0.15	86.84	....	....
25	....	5,670	2,400	6.2	13.3	4.73	0.06	0.05	0.08	84.39	....	....
28	....	5,700	2,507	4.6	17.5	4.69	0.06	0.06	0.22	83.79	....	....
4	....	5,700	2,646	4.5	17.5	4.68	0.06	0.16	0.17	83.90	....	....
	Average..........	5,670	2,506	5.5	15.3	4.74	0.05	0.14	0.13	83.93	....	....
16	DeLaval Alpha......	5,400	1,152	3.8	23.1	4.80	0.10	0.09	0.45	85.30	....	....
19	Acme................	5,530	1,088	5.8	14.5	5.00	0.12	3.00	0.08	84.29	....	....
2	....	5,470	996	5.4	16.5	4.71	0.09	0.80	0.15	81.09	1.03	1.03
	Average..........	5,470	1,080	5.0	18.0	4.84	0.10	1.30	0.23	83.56	....	....
21	Jumbo................	6,470	1,650	5.8	14.0	4.82	0.35	0.25	0.12	80.43	....	....
26	....	6,230	1,550	5.0	16.0	4.79	0.15	0.07	0.95	81.24	....	....
29	....	6,730	1,674	4.9	16.3	4.74	0.14	0.50	0.13	76.56	3.36	2.01
	Average..........	6,480	1,625	5.2	15.4	4.78	0.21	0.27	....	79.41	....	....
22	United States........	7,300	2,112	4.7	17.0	4.72	0.07	0.10	0.10	85.27	2.31	1.09
23	No. 1 B...............	7,330	1,940	5.7	14.4	4.75	0.11	0.95	0.07	85.27	2.43	1.25
30	....	6,970	2,400	4.6	16.3	4.65	0.07	1.00	0.12	83.32	....	....
1	....	7,330	2,114	5.7	14.3	4.65	0.07	0.25	0.07	86.26	2.53	1.20
	Average..........	7,230	2,142	5.2	15.5	4.69	0.08	0.58	0.09	85.03	2.43	1.18
5	Reid's Improved.....	5,830	2,371	6.0	14.0	4.80	0.07	0.05	0.01	81.87	....	....
6	Danish †..............	5,600	2,568	4.8	17.3	4.78	0.08	0.05	0.10	76.68	3.54	1.38
	Average..........	5,715	2,470	5.4	15.7	4.79	0.07	0.05	0.06	78.88	....	....
18	United States No. 3..	8,000	576	5.6	15.0	4.58	0.11	0.45	0.06	82.98	So	ur
2	....	8,000	603	7.0	12.5	4.71	0.03	0.50	0.15	81.09	0.37	0.61
	Average	8,000	590	6.3	1.38	4.65	0.07	0.48	0.11	82.03	....	....
17	United States No. 5..	8,000	255	5.7	16.0	....	5.13	....	....	.....	....	....
17	DeLaval Alpha No. 2*	6,900	300	5.5	1.58	4.91	0.20	....	0.18	84.45	....	....
17	DeLaval Alpha No. 3	6,000	615	3.8	22.7	....	0.12	....	....	....	....	....

*This machine had been run for some years at the Station and one of the bearings was badly worn. An "1895 Alpha No. 2" was bought by the Station soon after the school was closed which in nme successive trials on a little over 300 pounds of milk per trial skimmed 355 pounds per hour, leaving 0.06 per cent fat in the skim milk.

† Three other runs of this machine were made, in which it continued to do good skimming. Several circumstances combined to make the records of these runs faulty. So far as observed, however, the machines did as good work during these runs as in the two preceding.

Date of Separation.	II. SEPARATOR.	Farrington alkaline tablets used to measure acidity.	Temperature at beginning of Churning.	Temperature, end of churning.	Time of churning in minutes.	Per cent of the total Fat in Skim Milk.	Bowl Slop.	Butter Milk.	Theoretical per cent of Butter Fat recovered.	Actual per cent of Butter Fat recovered.	Per cent of mechanical loss.	Theoretical pounds of 80 per cent Butter made per 100 lbs. fat	Actual pounds of 80 per cent Butter made per 100 lbs. fat.
14	DeLaval................	...	48	53	31	1.0	0.1	0.1	98.8	95.1	3.7	123.5	118.9
15	Alpha Turbine.........	3½	48	56	43	0.5	0.0	0.2	99.3	97.3	2.0	124.1	121.6
24	....	2	50	54	34	1.1	0.1	0.3	98.5	92.1	6.4	123.1	115.2
25	....	1½	48	58	63	1.0	0.0	0.3	98.7	96.2	2.5	123.1	120.2
28	....	3	50	56	30	1.0	0.0	0.6	98.4	92.3	6.1	123.0	115.4
4	....	3¼	50	58	74	0.8	0.0	0.6	98.6	103.3	+4.7	123.2	129.1
	Average................	...	49	56	46	0.9	0.0	0.4	98.7	96.1	2.6	123.4	120.1
16	DeLaval Alpha.........	3½	56	63	77	1.6	0.0	1.8	96.6	87.7	8.9	120.7	109.6
19	Acme....................	3½	46	55	26	2.1	0.5	0.3	97.1	94.4	2.7	121.4	118.0
2	....	3¼	47	56	70	1.6	0.1	0.2	98.1	90.0	8.1	122.6	112.5
	Average............	...	50	58	58	1.8	0.2	0.8	97.3	90.7	6.6	121.6	113.4
21	Jumbo..................	3½	48	52	31	6.0	0.2	0.6	93.6	97.7	+4.1	117.0	122.1
26	....	2½	52	52	10	2.5	0.1	0.6	96.8	90.0	6.8	121.0	112.5
29	....	3	47	52	57	2.4	0.3	0.3	97.0	92.0	5.0	121.2	115.0
	Average............	....	49	52	33	3.6	0.2	0.4	95.8	93.2	2.6	119.7	116.5
22	United States..........	4	50	58	45	1.2	0.1	0.3	98.4	98.4	0.0	123.0	123.0
23	No. 1 B................	3	46	54	81	2.0	0.6	0.2	97.2	95.2	2.0	121.5	119.0
30	....	1½	46	58	100	1.2	0.6	0.3	97.9	85.6	12.3	122.4	107.0
1	....	1½	49	56	50	1.2	0.1	0.1	98.6	92.4	6.2	123.2	115.5
	Average............	....	48	57	69	1.4	0.4	0.2	98.0	92.9	5.1	122.5	116.1
5	Reid's Improved.......	3½	50	58	30	1.2	0.1	0.3	98.4	92.2	6.2	123.0	115.2
6	Danish..................	3½	50	58	30	1.5	0.1	0.3	98.1	93.5	4.6	122.8	116.9
	Average............	....	50	58	30	1.4	0.1	0.3	98.3	92.9	5.4	122.9	116.0
18	United States No. 3....	3½	46	52	48	2.0	0.1	0.2	97.7	92.0	5.7	122.1	115.0
2	....	3¼	47	56	70	0.6	0.1	0.2	99.1	90.0	9.1	123.9	112.5
	Average............	......	47	54	59	1.3	0.1	0.2	98.4	91.0	7.4	123.0	113.8
17	United States No. 5.. DeLavel Alpha Nos. 2 and 3.	2½	53	60	20	2.4	0.0	0.4	97.2	84.1	13.1	121.5	105.1

MECHANICAL LOSSES.

The mechanical losses, or in other words, the fat originally present in the milk, which is not accounted for in butter, skim milk, buttermilk or bowl slop, outweigh the entire losses in the by-products about three-quarters of the time. These large losses have always been noted in dairy school work and are due to the conditions of student labor. The unavoidable mechanical losses on the amounts of milk used ought not to exceed two per cent. Had fewer persons handled the milk and its products less loss would probably have taken place, but on the other hand the primary objects of the school would have been defeated.

CHURNING.

There were but two cases of buttermilk containing more than 0.22 per cent of fat. One of these was caused by high temperature of churning (63°); the other, by some unknown cause. Omitting these, the average buttermilk contained but 0.12 per cent. fat; including these, 0.17 per cent. fat. The average churning temperature was higher than that of the school session of 1893, (53° in 1893, 55.5° in 1894), yet the losses in the buttermilk were quite as small as the preceding year.

COMPARISON OF STEAM MILK TESTERS.

The laboratory was equipped with the steam testers manufactured by the Moseley & Stoddard Co., Rutland, Vt., the Vermont Farm Machine Co., Bellows Falls, Vt., and with the "Russian" tester, manufactured by P. M. Sharples, West Chester, Pa. Comparative trials of the first two machines named, (twenty-eight tests in the Stoddard, and thirty in the Farm Machine Co. tester,) showed 4.75 and 4.78 per cent. fat respectively. The tendency throughout seemed to be towards slightly higher results in the Farm Machine Co.'s tester.

At first the Russian gave on the average about two-tenths of one per cent. less than either of the other machines. Further and extended comparative trials lessened this difference. A series of tests covering nearly a hundred analyses showed on the average the following comparative results:

Steam Turbine, 5.19 per cent. fat; Russian, 5.08 per cent. fat.

Discarding four results in which the differences are wide, and leakage of fat observed or suspected, the comparative results are: Steam Turbine, 5.18 per cent.; Russian, 5.09 per cent. The graduation of bottles for each machine was found to be correct and the difference found, 0.10 per cent. on the average, appears fundamental. The Russian test exceeded the steam Babcock in less than ten per cent of the trials, the largest excess being 0.05 per cent. fat in a single trial. In a quarter of the tests the Russian test ran below the steam Babcock 0.20 per cent. or more.

A series of comparative tests of the steam Babcock and the gravimetric (Adams) methods recently made, seems to indicate a tendency towards slightly high results on the part of the steam turbine Babcock.

POWER CONSUMED.

The table on page 153 shows the power consumed by several of the belt separators as measured by the dynamometer, and the last report shows further data of the same nature. Dynamometer tests, however, cannot be applied to a turbine separator and since steam consumption is greater than horse power indicated, the comparison of one with the other would be unjust to the turbine. The comparative steam consumptions of the DeLaval Alpha Turbine and the United States No. 1 B. Belt Separator were carefully determined this year by Prof. A. W. Ayer of the Mechanical Department of the University, whose report follows:

PROF. JOSEPH L. HILLS,

Director Vermont Agricultural Experiment Station,

Burlington, Vt.

SIR :—I hand you herewith the results of certain tests made under my supervision, and having for their object the determination of the relative economy in the use of steam of the Alpha No. 1 Cream Separator, (steam turbine machine) made by the DeLaval Separator Company, of New York, and the No. 1 B United States Cream Separator, (belt machine) made by the Vermont Farm Machine Company, of Bellows Falls, Vt. In these tests it was intended to have both machines operated under the most favorable, and as far as possible, under similar conditions, and this design was carried out as far as the surroundings would allow.

The tests upon the Alpha machine were conducted in the creamery building of the Experiment Station, and during the tests the separator itself was under the care of Mr. G. E. Humphrey, of Essex Junction, Vt., for tests Nos. 1 to 3, and under the care of Mr. C. W. McBride, of Colchester, Vt., for tests Nos. 4 and 5, both of whom were entirely familiar with the running of machines of this type. The tests upon the United States machines were conducted in the Engineering Building of the University of Vermont, and during the tests the management of the separator was in the hands of Mr. M. H. Remington, of the Vermont Farm Machine Company. In all the tests the handling and weighing of the milk was looked after by Mr. J. E. Finn, dairyman of the Experiment Station.

TESTS UPON TURBINE MACHINE.

The separator was placed upon the first floor of the creamery building, and the exhaust steam was piped to a surface condenser in the basement. After condensing, it was collected in a barrel, and weighed on platform scales. The steam pressures at the boiler and at the separator throttling valve were taken at two minute intervals. The speed of the separator was taken twice during each test. There was no back pressure in the condenser.

In each test, everything being in readiness, the milk was weighed into the warming vat, and, having been brought to the desired temperature, the cock was opened from the warming vat, allowing the milk to enter the separator. At the instant of opening the cock, a gong was rung by the separator attendant, which served to notify the observer at the condenser that the test had begun. The time of ringing was also noted by the observer. As the last of the milk left the vat, the cock at the separator was closed, the gong again rung, and the time noted as the end of the test. Two pails of water were used in each test for washing the milk and cream from the sides of the vat, and the weight of water so used was added to that of the milk previously weighed into the vat, since it also passed through the separator during the test. This combined weight is given in column 8 of the table.

The results of the test are given in the following table.

TABLE I.—TESTS TO DETERMINE THE STEAM CONSUMPTION OF THE DELAVAL ALPHA NO. 1 SEPARATOR. (TURBINE.)

1	2	3	4	Steam Pressure, lbs. per sq. in.		7	8	9	10	11	12	13
No. of Test.	Date of Test.	Duration of Test.	Speed of Seperator, Revolutions per Minute.	5 At Boiler.	6 At Separator.	Weight of Steam Used, lbs.	Weight of Milk Separated, lbs.	Temperature of Milk. Degrees Fahr.	Rate of Separation, pounds of Milk per Hour.	Per cent of Fat left in Milk.	Pounds of Milk Separated per lbs. of Steam.	Pounds of Steam Required to Separate 1,000 Pounds of Milk.
1	February 15, 1895,	17 m., 35 sec.	5,750	94.1	52.4	56.25	752	85	2,567	0.02	13.37	74.8
2	February 16, 1895,	17 m., 56 sec.	5,600	87.2	51.0	57 25	758	65	2,536	0.04	13.24	75.5
3	February 18, 1895,	27 m., 0 sec.	5,700	91.2	49.2	87.00	1246.5	70	2,548	....	13.18	75.9
4	February 19, 1895,	18 m., 17 sec.	5,800	95 6	48.7	58.25	768	70	2,521	0.03	13.18	75.9
5	February 21, 1895,	43 m., 8 sec.	5,800	99.2	48.0	138.50	1845.5	70	2,567	0.04	13.32	75.0

TESTS UPON BELT MACHINE.

In these tests the separator was driven by a plain slide valve vertical steam engine, controlled by a throttling governor. The cylinder was four inches in diameter and the stroke was four inches, the cut-off being at about three quarters stroke. This engine was built in the shops of the Department of Mechanical Engineering of the University of Vermont, and was in first-class running condition at the time of the tests. The speed of the engine during the tests was about 350 revolutions per minute, at which speed its rated capacity would be about three horse-power. The fly-wheel of the engine was belted directly to the intermediate of the separator. The exhaust steam was piped to a surface condenser, and was discharged into and weighed in a tank upon platform scales. Indicator cards were taken from the engine at two minute intervals during each test, and from these the horse-power which it developed was calculated. It is to be noted that this was done merely for the sake of completeness in the tests, and that there is nothing with which it may properly be compared in the test upon the turbine machine. The boiler steam pressure was kept constantly at 70 lbs. during all the tests. The speed of the separator was taken twice during each test.

The weight of milk available was so small that in each test the skim-milk was run through the machine a second time, and the weight of milk given in column seven of the table is the sum of the weights of the whole milk and the skim-milk so run through. The indicator cards showed that there was no noticeable difference in the power required, whether whole or skim-milk was run through the separator, and I believe that no error is introduced into the results by this procedure. The manner of stopping and starting each test was similar to that employed in the tests upon the turbine machine. No water was used to wash down the sides of the vat in these tests, this being sufficiently accomplished by pouring back the skim-milk.

The results of the tests are given in the following table:

TABLE II.—TESTS TO DETERMINE THE STEAM CONSUMPTION OF THE NO. U. S. 1 B CREAM SEPARATOR.

(DRIVEN BY 4x4 ENGINE.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
No of Test.	Date of Test.	Duration of Test.	Speed of Separator, Revolutions per minute.	Boiler pressure, Pounds per square inch.	Weight of Steam used, Pounds.	Weight of Milk Separated, lbs.	Temperature of Milk, Degrees, Fahr.	Rate of Separation, Pounds of Milk per Hour.	Percent of fat left in Milk.	Horse Power Developed by Engine.	Steam used per Horse-Power per Hour by Engine.	Pounds of Milk Separated per Pound of Steam.	Pounds of Steam Required to Separate 1,000 lbs. of Milk.
6	August 14, 1895,	18 m., 40 sec.	7,300	70	49.0	730	80	2,346	0.05	2.68	58.8	14.90	67.1
7	August 16, 1895,	18 m., 30 sec.	7,300	70	49.0	761	84	2,468	0.05	2.61	60.9	15.53	64.4
8	August 19, 1895,	15 m., 20 sec.	7,300	70	44.0	690	80	2,701	0.06	2.86	60.2	15.68	63 8
9	August 21, 1895,	15 m., 45 sec.	7,300	70	44.5	684	80	2,607	0.05	2.60	65.2	15 37	65 1

For convenience in the further discussion of the tests, the average values of the figures given in the last two columns of Table I and II are here reproduced.

TABLE III.

TYPE OF SEPARATOR.	Pounds of Milk Separated per pound of Steam.	Pounds of Steam Required to Separate 1,000 Pounds of Milk.
DeLaval Alpha No.1 Turbine, average of 5 tests.	13.26	75.4
United States No.1 B Belt Machine, average of 4 tests.............	15.37	65.1

From these results it appears that under the conditions prevailing during the tests, the belt machine used only 86.3 per cent of the steam required by the turbine, while separating the same amount of milk. By reference to column twelve of Table II, it will be seen that the steam engine used to run the belt machine was not at all economical in the use of steam per horse-power per hour, although this is probably about what is used in any steam engine as small as this. With an automatic engine of say 15 horse-power, there should be no great difficulty in cutting down the steam consumption to 40 lbs. of steam per horse-power per hour, while with still larger engines a greater economy in the use of steam could be obtained. Hence, while the saving in steam by the belt machine, as shown by Table III, might not be considered sufficient to warrant the extra expense of an engine, if only one separator were to be used, I believe there should be no doubt as to the type of separator to be used if several of them were to be run in the same creamery, and that the belt machine in such cases should be chosen. It should, however, be born in mind that an engine either uuder-loaded or over-loaded is never economical in the use of steam, and that therefore care should be taken to see that the engine is properly proportioned to the work to be done.

Respectfully submitted,

A. W. AYER,

Prof. Mechanical Engineering,

University of Vermont.

III.—THE LACTANALYT, A NEW MILK TESTER.

The Lactanalyt is an instrument designed to show the per cent. of fat in milk. It is sold by the Lactanalyt Manufacturing Co., 822 Broadway, N. Y., for five dollars. Several have been sold in this State. It is claimed by the manufacturers in their circular to be "the quickest, simplest and most accurate method of testing milk yet devised." In these days when the Babcock test is so widely known and used it is somewhat surprising to learn from the circular that "until the present day there has not been in existence a simple, reliable method for testing the quality and value of milk except the laborious and expensive one of a scientifically conducted analysis, which can only be effected and carried out by a trained chemist," and that "the only milk test endorsed by the chemists and Boards of Health everywhere is Prof. Weigel's 'Lactanalyt.'"

The Lactanalyt consists of a glass tube with a bulb at the bottom, a dropping pipette, a glass cylinder marked at 10.3 C. C., three liquids, A (an alkaline material,) B (alcohol,) C (ether,) a brush and a metallic measure. It is essentially a modified butyrometer. No milk containing less than 1.20 per cent. fat is measured by the scale. There appears to be no fixed relation between the cylinder and the graduated portion of the neck of the bulbed tube. The fat is measured in the tube while the brush is inserted in the bulb and the wire handle of indefinate size protrudes through the fat column. A measure full of milk (10.3 C. C.) is poured into the bulbed tube, from one to five drops of the liquid A is added, then the measure full of liquid B is poured in and the two are mixed with a rotary motion of the brush; a measureful of liquid C is then added, further brush mixing given and the bulb is warmed either by the heat of the hand or by immersion in water at or below 105 °F. The metallic measure is then applied to the etherial fat column in the neck to read the percentage of fat.

The following comparative analyses have been made, great care having been taken to follow directions. Several persons, chemists and others, have used the Lactanalyt sold to this station, and as a rule have been unable to get agreement with the Babcock test.

PER CENT OF FAT BY

Babcock.	Russian Babcock.	Lactanalyt.	Babcock test exceeds Lactanalyt.	Babcock.	Russian Babcock.	Lactanalyt.	Babcock test exceeds Lactanalyt.
5.20	5.10	3.95	1.25	4.65	4.50	4.50	0.15
5.60	5.40	4.30	1.30	4.78	4.75	4.30	0.48
5.63	5.55	5.20	0.43	4.70	4.60	4.40	0.30
4.58	4.40	3.50	1.08	6.10	....	4.15	1.95
4.13	4.00	3.50	0.63	4.18	....	3.10	1.18
5.55	5.35	4.30	1.25	5.63	....	4.10	1.53
4.60	4.45	4.00	0.60	5.10	....	3.60	1.50
5.30	5.15	4.10	1.20	4.70	....	3.60	1.10
5.20	5.25	4.30	0.90	5.00	....	3.30	1.70
3.68	3.60	3.20	0.48	6.55	....	4.50	2.05
4.00	3.85	3.80	0.20				

BABCOCK.	LACTANALYT.	BABCOCK TEST EXCEEDS LACTANALYT.	BABCOCK.	LACTANALYT.	BABCOCK TEST EXCEEDS LACTANALYT.
.75	3.00	0.75	5.05	4.40	0.65
6.40	6.30	0.10	4.45	4.20	0.25
4.45	4.30	0.15	5.40	4.90	0.50
5.90	5.55	0.35	5.35	5.30	0.05
5.00	5.20	—0.20	5.35	4.90	0.45
4.40	4.50	—0.10	4.40	4.40	0.00
5.50	5.90	– 0.40	6.10	5.95	0.15
5.58	5.30	0.28	5.23	5.00	0.23
5.00	5.00	0.00			

Increasing the amount of liquid A used did not better results, neither did the substitution of pure anhydrous ether in the place of that sent with the apparatus. These changes in the method were made at the suggestion of the manufacturers, who did not otherwise attempt to account for the low results obtained. Results obtained with a second bottle of liquid A were nearer the Babcock figures, but were quite irregular, sometimes agreeing well and sometimes not agreeing. The dregs of the first bottle of liquid A gave a few close results. Admitting, however, the possibility of raising all the fat in the milk, it may well be doubted whether any method which measures the resulting product with a wire brush handle of indefinate size protruding through the column to be estimated can justly claim to be "the most accurate method of testing milk yet devised."

IV.—THE EFFECT OF FATIGUE UPON THE QUANTITY AND QUALITY OF MILK.

Seventeen cows in milk were purchased by the Station on April 18, 1894, in Brookfield, Orange County, driven ten miles to Northfield, and shipped fifty miles to Burlington by rail, then driven a mile and a quarter through city streets to their new quarters at the station farm, arriving at about dusk, having been all day on the road. Eight more were bought in early October, and traveled the same route under very similar conditions.

The analyses of the milks given the evening of and morning after arrival by the individual cows of both lots, the analyses of composite (eight milking) samples taken April 20, P. M., to 24 A. M., and of similar samples taken May 1, P. M., to 5 A. M., October 16, P. M., to 20 A. M., on the second lot are given in the following table:

Name.	Night of Arrival.				Morning after Arrival.				Two to Six Days After Arrival.				Two Weeks After Arrival.			
	Milk. lbs.	Total Solids. %	Fat. %	Solids not fat. %	Milk. lbs.	Total Solids. %	Fat. %	Solids not fat. %	Milk. lbs.	Total Solids. %	Fat. %	Solids not fat. %	Milk. lbs.	Total Solids. %	Fat. %	Solids not fat. %
Julia	7.1	16.13	6.38	9.75	7.4	15.31	5.88	9.43	9.8	14.44	4.67	9.77	10.0	13.72	4.20	9.52
Flora.........	8.8	14.68	5.34	9.34	7.7	15.79	6.53	9.26	6.6	15.37	6.50	8.87	9.8	13.17	4.18	8.99
Fanny........	9.4	14.06	4.86	9.20	8.3	16.51	7.85	8.66	9.4	12.87	4.45	8.42	9.7	12.68	3.90	8.78
Jessie	4.7	14.50	4.92	9.58	7.3	.....	9.20	....	7.4	14.48	5.70	8.78	8.3	14.49	5.20	9.29
Fairie	9.1	14.26	4.40	9.86	9.7	16.47	6.95	9.52	11.6	14.57	5.17	9.40	10.5	12.04	3.95	9.09
Dandelion	5.0	14.41	5.13	9.28	6.7	.....	8.33	....	8.1	14.38	5.29	9.09	6.3	14.16	4.80	9.36
Jennie........	10.5	14.00	4.75	9.25	9.3	15.97	6.85	9.12	11.2	13.81	4.58	9.23	10.7	13.08	4.00	9.08
Belle Black...	11.2	14.31	5.05	9.26	8.6	16.17	7.03	9.14	9.7	13.80	4.76	9.04	10.4	13.23	3.98	9.25
Violet........	2.9	12.28	3 13	9.15	8.2	15.72	6.58	9.14	8.0	14.38	5.23	9.15	7.7	13.73	4.40	9.33
Bess..........	8.1	13.31	4.11	9.20	7.5	16.90	7.53	9.37	10.3	14.21	4.86	9.35	9.1	14.70	4.98	9.72
Dora	5.7	14.54	5.20	9.34	4.7	17.52	8.18	9.38	6.6	14.69	5.40	9.29	7.2	14.85	5.25	9.60
Red Top......	11.7	13.19	4.49	8.70	11.2	14.73	5.92	8.81	14.3	12.87	3.98	8.87	12.4	12.06	3.40	8.86
Clover.... ...	2.8	19.05	8.53	10.52	3.2	19.42	8.63	10.79	5.0	16.87	6.30	10.57	4.4	16.60	6.08	10.52
Brownie......	6.8	16.21	6.80	9.41	6.7	17.84	8.00	9.84	8.6	14.91	5.40	9.51	8.5	14.00	4.38	9.62
Golden Rod...	4.4	17.47	7.20	10.27	4.1	18.84	9.13	9.71	5.4	17.05	6.80	10.25	4.9	14.79	5.18	9.61
Rowena	13.0	14.99	5.20	9.79	10.1	15.87	6.35	9.52	12.7	14.30	4.60	9.70	10.7	13.31	4.30	9.01
Bettie........	5.2	16.72	7.14	9.58	4.0	17.39	7.78	9.61	5.0	15.33	5.33	10.00	2.3	14.65	5.10	9.55
Average.......	7.5	14.95	5.45	9.50	7.4	16.70	7.28	9.42	8.8	14.61	5.24	9.37	*8.8	13.90	4.55	9.35
Jersey Lily...	10.1	15.06	5.38	9.68	9.4	15.97	6.35	9.62	....	.....	....	.....	13.0	13.79	4.55	9.24
Regina........	7.8	12.13	3.48	8.65	11.7	13.30	4.35	8.95	....	.....	....	.....	12.6	13.39	4.22	9.17
Portelette.....	9.9	14.05	4.85	9.20	12.9	14.91	5.98	8.93	....	.....	....	.....	21 5	14.26	5.05	9.21
Waxy	8.0	12.60	3.75	8.85	14.5	16.69	7.80	8.89	....	.....	....	.....	11.0	13.74	4.55	9.19
Jessaline	9.5	12.86	3.65	9.21	13.7	14.13	5.40	8.73	....	.....	....	.....	12.5	13.44	4.45	8.99
Lady Le Brocq	10.2	13.44	4.20	9.24	10.8	14.81	5.40	9.41	....	.....	....	.....	12.1	14.41	5.15	9.26
Rhoda	7.3	14.77	5.85	8.92	10.5	14.65	5.85	8.80	....	.....	....	.....	7.8	14.69	5.20	9.49
Goldie........	8.5	17.88	9.15	8.73	4.3	15.34	6.05	9.29	....	.....	....	.....	10.8	15.41	5.90	9.51
Average....	8.8	14.10	5.04	9.06	11.0	14.98	5.90	9.08	....		....	.....	12.7	14.14	4.88	9.26

*Omitting Bettie who aborted early in May.

The average of both lots was:

	Pounds of Milk.	Total Solids. Per Cent.	Fat. Per Cent.	Solids not fat. Per Cent.
Night of arrival......... ...	7.9	14.68	5.32	9.36
Morning after arrival.......	8.6	16.10	6.80	9.30
Two weeks after arrival.....	10.0	14.00	4.66	9.34

The milk flow was lessened by fatigue, the general quality decidedly bettered and the butter yields increased. Half of the cows gave richer and half essentially the same of poorer milk on the evening of the day of travel as they gave after recovery from fatigue. All gave richer milk the morning following the travel than two weeks later and with three exceptions richer than the night before. The fat was the most variable constituent, the solids not fat remaining quite uniform.

V. EARL OF MONTAGUE, 25,009 A. J. C. C.

EARL OF MONTAGUE.—25,009.

- **YOUNG PEDRO.—9033.**
  Sire of
  Eurotisama, 27.01½
  " one year, 945.09
  Pedronina, 21.03
  Albert's Lilley, 3d, 20.12½
  Dicta, 20.09
  Riotress, 3d, 17.03½
  Young Lass, 17.03½
  Patona, 16.14½
  Chansonnette, 2d, 16.09
  Beauty of Hamilton, 15.15
  Fanelia, 2d, 15.06
  Howdy, 15.03½
  - **PEDRO.—3187.**
    Sire of
    Golightly, 23.04
    Pedro's Fame, 19.12
    Pedro's Mab, 16.10
    Skipover, 16.05½
    Pedro Alphea, 15.05
    B:iss, 14.08
    Pedro's June, 14.06
    - **DOMINO OF DARLINGTON.—2459.**
      Sire of
      Hattie of Briarcliff, 18.01
      Lelia of Briarcliff, 17.06½
      Viola of Briarcliff, 14.08
      Como of Briarcliff, 14.06
      Lorna of Briarcliff, 14.04
      Erudie of Briarcliff, 14.02
      Robinette, 14.01
    - 22.07
      778 lbs. in one year.
      EUROTAS.—2454.
  - 16.07
    RIOTER ALPHEA.—10,091.
    17.15
    17.01½
    - **JASON, JR.—3270.**
      Sire of
      Rioter Rhea, 19.03½
      Rioter Alphea, 16.07
    - 16.04
      CHANSONNETTE.—5695.
      19.03½
      16.09
      16.07
- **SULTANE POGIS.—42.157.**
  - **VICTOR HUGO POGIS.—11,256.**
    Grand sire of
    Nutshell. 2d, 19.02
    Tamy's New Year, 17.06
    - **RAMBLER OF ST. LAMBERT.—5285.**
      Sire of
      Rose of St. Lambert, 21.02½
      Rioter's Ruth, 19.06½
      Rioter's Queen, 17.08
      Oakland's Lily, 15.04
      Rioter's Beauty, 14.00
    - 17.12
      CROCUS OF ST. LAMBERT.—8,851.
      14.12¾
      Full sister to Mary Anne of St. Lambert.—36.12½.
  - 15.03½
    EASTERN SULTANE.—20,298.
    - **EASTERN CHIEF.—171. J. H. B.**
      Sire of
      Eastern Sultan, 15.03½
    - **MARIE LOUISA.—2472. J. H. B.**
      15.03½.

SARPEDON.—930.
Never had a daughter.

BEAUTY OF DARLINGTON—3736
21.11½

RIOTER, 2d.—*Imp.*—469.
Sire of
Eurotas, 22.07
Pet Gilford, 18.04½
Torfrida, 17.06½
And 2 others in the list.
15.00

EUROPA.—176.
22.07
17.06½
14 05½

WESTCHESTER.—1266.
Sire of
Chansonette, 16.04
Susie Allen, 15.12
CLOCHETTE D' OR.—5696.
16.04

STOKE POGIS, 3D.—2238.
Sire of
Mary Anne of St. L., 36.12½
Ida of St. L., 30.02½
Allie of St. L., 26.12
Mermaid of St. L., 25.13½
Nymph of St. L., 24.14
Naiad of St. L., 22.02½
Nora of St. L., 22.00
Niobe of St. L., 21.09½
And 20 others in the list.
BESSY OF ST. LAMBERT.—5482
16.02

STOKE POGIS, 3D:—2238.
Sire of
Mary Anne of St. L., 36.12½
And in 1 year, 867.14¾
And others as above.
LOLLY OF ST. LAMBERT —5480.
36.12¼
22.04¼
17.12

WELCOME.—202. J. H. B.

ZENOBIA.—86. J. H. B.

MERCURY.—432.
Sire of
Locusta, 21.07
Phaedra, 19.13
And 19 others in the list.
15 00

EUROPA.—176.
22.07
17.06½
14.05½

SMITH OF DARLINGTON.—2458.
Sire of
Anna Smith, 15.06
Nellie Darlington, 15.03
GRACE DARLINGTON.—5574.
24.01½
15.03½
15.03

INACLUS.—928.
Sire of
Euphrates, 16.05
15.03½
CLYTEMNESTRA.—2455.
17.05
14.08

STOKE POGIS.—*Imp.*—1259.
Sire of
Matilda, 4th, 21.08½
Lily of St. L., 2d, 18.12
La Petite Mere, 2d, 16.07
Le Clair's Marjoram, 15.03
Marjoram, 2d, 15.00
16.00
MARJORAM.—*Imp.*—3259.
15.03
15.00

BUFFER.—2055.
Sire of
Moss Rose of St. L,, 14.08½
Pearl of St. L., 14.02
MAY BUD OF ST. LAMBERT.—
5105.
14.11

BUFFER.—2055.
Sire of
Moss Rose of St. L.. 14.08½
Pearl of St. L., 14.02
CAMELIA OF ST. LAMBERT.—
5106.
14.00½

JUPITER.—93.
Sire of
Europa, 15.00
Leda, rate, 14.05½
Rate, 30.00.
ALPHEA.–171.
15.00

ON I OF JERSEY.
Rate, 19.11.
VIOLET OF DARLINGTON.—
Imp.—5573.
15.06.

RIOTER, 2D.—*Imp.*—469.
Sire of
Eurotas, 22.07
and four others in the list.
DIDO.—*Imp.*—1234.

MERCURY.—432.
Sire of
Locusta, 21.07
Phaedra, 19.13
Nymphaea, 18.07½
Richness, 17.05
Lerna, 15.12
Zalma, 15.05
Purest, 15.04
And 14 others in the list.
Rate, 14.05½.
LEDA.—799.
19.13
15.05½
15.03½

LORD MONCK.—304.
Sire of
Tidy of St. L., 14.02
AMELIA.—484.
15.12
14.00½

LORD MONCK.—304.
Sire of
Tidy of St. L., 14.02
AMELIA.—484.
15.12
14.00½

LORD LISGAR.—1066.
Sire of
Sweet Brier of St. L., 22.12
Jolie of St. L., 15.13½
Duchess of St. L., 15.13
Bijou of St. L., 15.04
Rosette of St. L., 14.03½
Clematis of St. L., 14.03
HEBE OF ST. LAMBERT.—5117.

The new station herd, bought in the spring and fall of 1894, was headed for about a year by a Jersey bull bred by Hon. G. S. Fassett, an animal of much individual excellence, of pure blood, but not eligible of registry because of neglect on the part of the owners of his ancestry.

In the spring of the present year (1895) the Station was offered a particularly desirable bull, then the head of the herd owned by the Pratt Institute, Brooklyn, N. Y. The bull, Earl of Montague, 25,009 A. J. C. C., was bought, is now in use at the Station farm, and its officers are justly proud of him.

A glance at his pedigree indicates that he is of noble lineage, while his portrait, the frontispiece of this report, shows him to be worthy of his ancestry. His former owner, Col. R. J. Kimball, of West Randolph, writes of him:

"The value of a bull lies in his ability to add to the value of his owner's herd. The old saying that 'like produces like or the likeness of some ancestor' applies to a bull, perhaps, more than to most animals. That one or two ancestors were good, is well enough so far as it goes, but that all were good or more than good is much better. Certain strains or families of Jerseys have shown the butter making ability to a remarkable degree, among which the Rioters, particularly the lines through Stoke Pogis and Rioter, 2d, are pre-eminent. Both of these lines appear through their best channels in the pedigree of the *Earl of Montague*. The blood of Rioter, 2d, nicked best with that of the Alphea family, and this family also through its best channel appears in this pedigree. It was this combination which produced the champion Eurotisama who is a sister of the Earl of Montague. Her record of 27 lbs. 1½ ozs. of butter in 7 days was good, very good, but her record of 945 lbs. 9oz. of butter within one year was far better, for it showed her ability to keep up her production for a long period. This breeding made possible the first of the big yearly records, for it produced Eurotas, (22 lbs, 7 oz. in 7 days, and 778 lbs. 1 oz. in less than one year), one of the ancestors of the Earl of Montague. The blood of Stoke Pogis nicked best with that of Lord Lisgar, and produced the more than famous Mary Anne of St. Lambert, whose record of 36 lbs. 12½ oz. of butter in 7 days and 867 lbs. 14¾ oz. in one year, long stood unbeaten. It also produced and is the backbone of the well known St. Lambert strain, and for years the fact that half or more of the blood in any animal was St. Lambert insured its sale at a good price. There are some where about 2,500 Jersey cows that have made over 14 lbs of butter in 7 days. Over one-half of these have more or less of the Rioter blood. It may be chance or not, but the blood of Alphea or Lord Lisgar generally shows there too. There is no cow with whom a bull like the Earl of Montague is not fit to mate; there are few whose calves would not be better than their dams with this bull for their sire, and the poorer the dam the greater would be the improvement."

VI. MISCELLANEOUS FODDER CROPS.

A series of experimental plots containing a tenth of an acre each was laid out in the spring of 1894 on a piece of land south east of the farm buildings. The soil was a rather stiff clay loam and had laid in sod for many years previous. An attempt was made to grow several leguminous crops, but many failed to make satisfactory growth, partly because of the overwhelming amount of quack grass, and partly because of the extreme drought. Four plots of spring sown clovers, red, mammoth red, crimson and alsike were turned under. Horse beans, early planted, dried up and blighted, while a plot of rape, the single non-leguminous crop grown, was eaten up by grass-hoppers.

The following crops survived the attacks of insects, drought, etc., and were harvested. Analyses, weights and amounts of food ingredients per acre are shown in the following tables:

Plot Numbers.	Crop.	Original Substance.		Composition of Dry Matter.							
		Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
2	Soja Bean (Green)	69.88	30.12	7.95	11.35	23.88	53.77	3.05	1.88	0.504	1.965
3	Soja Bean (Black)	68.38	31.62	7.56	13.68	23.10	51.59	4.07	2.18	0.561	2.228
4	Villous Vetch	77.20	22.80	9.59	22.80	26.34	38.81	2.46	3.65	0.716	3.207
5	Villous Vetch and Oats	59.74	40.26	8.94	14.77	30.52	43.00	2.77	2.36	0.575	2.527
6	Spring Vetch	69.82	30.18	9.39	18.94	26.37	43.46	1.84	3.03	0.606	2.918
7	Spring Vetch and Oats	53.20	46.80	7.72	17.23	23.84	48.97	2.24	2.76	0.500	1.690
8	Serradella	72.30	27.70	10.50	14.03	29.66	42.23	3.58	2.24	0.648	2.030
9	Flat Pea	Per	e nn i	al—	No	crops	first	yea	r.		

Plot Numbers.	Crop.	Total Yield.	Original Substance.		Composition of Dry Matter.							
			Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
2	Soja Bean (Green)	12860	8987	3873	308	440	925	2083	118	73	20	77
3	Soja Bean (Black)	9890	6763	3127	236	428	722	1613	127	68	18	71
4	Villous Vetch	7050	5443	1607	154	366	423	624	40	59	12	52
5	Villous Vetch and Oats	4020	2402	1618	144	239	49	696	45	38	9	41
6	Spring Vetch	7880	5502	2378	223	452	626	1033	44	72	14	69
7	Spring Vetch and Oats	4100	2181	1919	148	330	457	941	43	53	10	32
8	Serradella	7650	5531	2119	223	297	628	895	76	47	14	48

2-3. Soja (or Soy) Beans, green and black medium varieties, (*Soja hispida*). Seed was obtained from the Hatch Experiment Station of the Massachusetts Agricultural College; 27 inch rows. These beans were grown in 1893 as well as in 1894, and proved satisfactory each year. As explained in the last report they are of Japanese origin, make good dry fodder or ensilage and are well relished by cattle. No other leguminous hoed crop which we have grown have given us better returns in tonnage of green fodder, dry matter or protein. The green variety this year yielded at the rate of six and a half tons green fodder, two tons dry fodder and nearly a quarter of a ton of protein to the acre. The crop was poorer in protein than last years' growth.

4-5-6-7. Villous and Spring Vetches with and without oats. (*Vicia villosa, Vicia sativa*) broadcast. The vetches are slender twining plants which are frequently grown with oats as a support. They are rich in protein and relished by cattle either green, dry or ensilaged. The vetch and oat plots were cut a little later than they should have been. Although good growths were made, our experience with these crops for several years does not lead us to consider them equal to peas and oats.

8. SERRADELLA, 27 inch rows. This is a fine leaved plant of low growth, difficult to harvest, yet fairly well liked by cattle. About a ton of dry matter to the acre was harvested, not particularly rich in protein. It was thought that it might do better in a wetter season, but it has again (1895) done poorly and we cannot recommend it as a promising forage crop.

VIII.—FOUR WAYS OF PRESERVING FODDER CORN.

1. RESULTS OF PRESERVATION.

The Fifth and Sixth Reports of this Station contain statements of experiments made to test the relative value of the more common methods of preserving fodder corn.* The results of a repetition of the experiment noted in the Sixth Report form the body of the present article, being a comparison of the relative values of four methods of preserving fodder corn, viz:

1. Ensilaging the entire crop " ears and all ". (Whole Ensilage).
2. Picking the ears, cribbing, drying and grinding them, and feeding the meal together with the ensilaged stalks and husks (Stover Ensilage and Meal).
3. Stooking in large stooks (Corn Fodder).
4. Husking, cribbing, drying and grinding the ears and feeding the meal together with the stooked stalks (Corn Stover and Meal).

*Fifth Annual Report, pp. 75-86; Sixth Annual Report, pp. 163-197.

The results of the test of two years ago were quite decisive, and were, as a whole, in line with those obtained from similar experiments made elsewhere; yet, a repetition was thought desirable, and the following experiment was planned and carried out.

DESCRIPTION OF METHODS OF PRESERVATION.

When the corn was harvested at the Station farm in the fall of 1894, it was divided into four portions:

1. Two rows were run through a cutter, cutting them into half inch lengths, ears and all, and put into the silo (Whole Ensilage).

2. The next two rows had the ears picked off in the field and the stalks run through the same cutter into another silo. The ears were sacked and brought to the barn on each load, weighed, husked at once and the weighed husks cut into the silo together with the stalks to which they belonged. The re-weighed ears were spread out to dry for a few days in a large room, and then cribbed, dried and ground, cob and all, for feeding in connection with the stalks (Stover Ensilage and Meal).

3. The next two rows were brought from the field and put in large stooks near the barn. Each stook as it was wanted for feeding during the winter was run through the cutter, ears and all, being cut in the same lengths as the ensilage (Corn Fodder).

4. The fourth two rows were brought to the barn and stooked in the same way, and in about a week were husked, the stalks re-stooked, the ears spread for drying in a large room, then cribbed, dried and ground, cob and all, and fed in connection with the stooked material which was run through the cutter from time to time as wanted for feeding during the winter. (Corn Stover and Meal).

Each eight rows through the field were treated the same way, so that at the end the corn crop was divided into four equal parts. One part was all put into the silo. The second part had the stalks put into the silo, the ears ground and fed with the ensilage of the stalks. The third part was stooked and fed ears and all together from the stook. The fourth part was stooked, then the ears husked and ground, and the meal fed with the cut stalks.

FODDER SAMPLING.

Each lot of corn for the silo and for the stooks was weighed on the large scales as it was brought into the barn. While it was being put into the silo an armful was taken from time to time, three or four to each load, at once weighed and put into a pile. At the end of the day, or, at most, at the end of the second day, whenever the "layer" was finished, these piles, which amounted to several hundred pounds, were removed, reweighed, run through the cutter, mixed thoroughly, weighed again, six samples of each taken for analysis and the remainder put into the silo. Samples of the ears and husks were also taken. This was done for both the whole ensilage and the stover ensilage.

The corn used in this experiment was taken from one field, but in order to assist in checking the results and to prevent errors it was divided into three parts in "layers," designated as "upper," "middle" and "lower." The corn from each part was separated in the silos by boards and was stooked in different rows.

Samples were taken from each layer. The data showing the composition of of the crop and its various parts at harvest is based upon the results of fifty determinations of dry matter and twenty-four complete fodder analyses. All fodders were weighed when fed. Samples of each ensilage were taken once each week in triplicate, while samples in duplicate were taken of the corn fodder and stover every time a stook was brought into the barn to be cut up, and once in three days throughout the feeding of each cut stook. The cob-meals were sampled periodically. There is, therefore, a complete record of the composition of the various parts as harvested and as fed. Both above and below the experimental ensilages, but separated from them by boards, were considerable amounts of non-experimental ensilage. There was, consequently, but little loss from spoiled ensilage. The corn which was stooked out of doors stood the winter fairly well. The last few stooks which were fed were smaller than the others, and were consequently more weatherbeaten. The stooked corn fed after the middle of March was not as palatable as it would have been if it had been better stooked.

The field from which the corn was cut was planted to Sanford and Red Cob corn in the proportion of two-thirds and one-third. The harvesting was planned so that the cut corn in the silo was mixed in about these proportions. The exceeding dryness of the summer prevented a large crop. The Sanford corn headed out very low, and the leaves ripened before their time. The corn was much less heavily eared than we wished, and was cut earlier than usual.

This experiment involved quite as much work as did the similar one detailed in our Sixth Report. It entailed five and a half months of experimental feeding of fourteen cows, over twenty thousand barn weights, the analyses of about five hundred fodder samples for total dry matter, over a hundred complete fodder analyses, and over three hundred milk analyses, calling for several thousand separate determinations in the chemical laboratory and, finally, many hundred hours of arithmetical calculations.

The printing of the original data would require some hundreds of pages and over burden the report. It has, therefore, seemed best not to publish the original figures of the daily routine, but only the totals for the different layers and feeding periods. But even in this very condensed form the bulk of figures is too great to be readily comprehended if printed with the discussion of the results, and would deter the general reader from even a cursory examination. The merest outlines of summaries only are given in the discussion. The totals for the different layers and feeding periods, necessary, as matters of record and as the basis for the conclusions drawn, are inserted at the close of this article, under three headings:

I. Average Analysis of Crop and its Various Parts as Harvested and Fed.

Composition at harvest as shown by analyses of the entire plant and by calculations from the analyses of the various parts, for each layer.

Average analyses of entire plant as harvested and, when ensilaged or stooked, for each layer and average of whole.

Average analyses of corn stovers as harvested and when ensilaged or stooked.

Average analyses of ears at harvest and of cob meals.

II. Losses of Food Ingredients by the Various Methods of Preservation.

Whole Ensilage.
Stover Ensilage with husks and ears.
Stover Ensilage (with husks).
Ears of Stover Ensilage.
Corn Fodder.
Corn Stover with husks and ears.
Corn Stover (with husks.)
Ears of Corn Stover,

III. Records of the Cows Individually and by Groups during the Experiment.

RELATIVE AMOUNTS OF DRY MATTER SAVED BY THE FOUR METHODS OF PRESERVATION.

The following table shows the relative efficiency of these various methods of handling the corn crop, on the assumption that the dry matters saved are of equal feeding value :*

METHOD OF HANDLING CROP.	Weight as harvested. lbs.	Dry Matter in crop as harvested. lbs.	Dry Matter of crop saved ready for feeding. lbs.	Loss in dry matter. lbs.	Per Cent of loss in dry matter. per cent.
Whole Ensilage...........	30,385	6,688	5,321	1,367	20
Stover Ensilage and Meal	30,068	6,732	5,512	1,220	18
Corn Fodder.............	30,385	6,688	5,339	1,349	20
Corn Stover and Meal......	30,068	6,732	5,375	1,357	20
Total.................	120,906	26,840	21,547	5,293	
Average............	30,227	6,710	5,387	1,323	20

*The summary of American digestion coefficients by Director W. H. Jordan of the Maine Experment Station, in the Experiment Station Record, Vol. VI., No. 1, p. 7, shows that, so far as trials thus far made can indicate, the digestibility of the various food ingredients in corn ensilage and corn fodder are nearly identical, with the exception of the ether extract; that those in corn stover (particularly the protein) are somewhat less digestible than those in entire plant, either ensilaged or stooked; and that those in cob meal, except the crude fibre, are much more digestible than those in the stalks. Combining the coefficients of the latter two in the proportions held by the dry matter of the stover and cob meal in the present experiment, the result shows a somewhat lower digestibility in stover and meal, for protein and fat, and the same digestibility for dry matter, fibre and nitrogen-free extract as in ensilage or fodder.

The results are practically identical, one-fifth of the entire dry matter being lost by each method. The slightly better results with the stover ensilage and meal are due to the fact that there was but ten per cent loss of dry matter in the ears. The ensilage itself lost 19.5 per cent, and the stooked stalks or corn stover 22.6 per cent.

These figures are remarkably similar to those obtained in the experiments of two years and four years ago, as will be seen by the following table :

	Per Cent of Loss in Dry Matter.		
	1890	1892	1894
Whole Ensilage	20	18	20
Stover Ensilage and Meal		21	18
Corn Fodder	19	18	20
Corn Stover and Meal		17	20

These figures are practically identical with the average of a large number of tests of the same point at various stations.

These four methods of preserving the corn crop seem to have about the same value when each is at its best. It should be borne in mind, however, that the stooks of corn fodder at the station were put up in the best possible manner, being of large size, carefully and firmly put together and the tops bound tightly so as to exclude rain and snow. The losses in small or poorly made stooks are usually larger, and the fodder less palatable than found in the station experiments. The ensilages, on the other hand, were at a disadvantage, because of the slow rate of feeding. Experiments at this and other stations seem to indicate that the larger part of the losses of dry matter in the silo takes place on the surface, and that losses are roughly inverse to the rapidity of feeding.

It is safe to say, therefore, that the losses of food in a good silo, well filled and of not too large feeding surface, are seldom more than those found in stooked fodder.

CHARACTER OF LOSSES.

The following table shows the distribution of the losses in feeding value among the various food ingredients :

	Percentage Losses from Harvesting to Feeding.							
	Dry Matter.	Crude Ash.	Crude Protein	Crude Fiber.	Nitrogen—free extract.	Ether Extract	Phosphoric Acid.	Potash.
Whole Ensilage..................	20	+3	12	5	30	16	18	+
Stover Ensilage and Meal..........	18	+3	6	5	27	11	7	8
Corn Fodder..	20	1	12	+3	31	26	16	8
Corn Stover and Meal............	20	6	10	2	29	21	6	16
Average.....	20	0	10	2	29	19	12	8

Notwithstanding the very different methods of handling, the losses are essentially the same in kind and degree, falling mainly upon the carbohydrates (starch, sugar, etc.) The ensilages appear to gain in ash, the out-of-door portions seem to lose. The apparent gain in ash in the ensilages may come from unavoidable errors of sampling, or from translocation of the ash, as suggested by Woll.* The character of the losses are similar to those found in the two experiments previously reported.

PER CENT OF LOSSES.

MATERIAL.	NUTRIENTS.	1890	1892	1894
Whole Ensilage........	Protein.............	13	11	12
Whole Ensilage........	Starch, Sugar, etc....	31	27	30
Corn Fodder...........	Protein..............	17	9	12
Corn Fodder...........	Starch, Sugar, etc....	24	27	31
Stover Ensilage and Meal	Protein.............	..	14	6
Stover Ensilage	Starch, Sugar, etc....	..	29	27
Corn Stover and Meal...	Protein............	..	9	10
Corn Stover...........	Starch, Sugar, etc....	..	23	29

* Fifth Annual Report Wisconsin Experiment Station, pp. 72-3.

RELATION BETWEEN LOSSES IN WEIGHT AND DRY MATTER BY THE FOUR METHODS OF PRESERVATION.

The losses in the silo are evident to the unaided senses. It is less easy to realize that fermentation is also at work in the stook, and that as large losses may occur there as in the silo, whether signs of heating are seen or not. This fact has been repeatedly shown, however, by many experiment stations. The following table is testimony in conformation of the data given in our sixth report on this point, (p. 180), showing that while corn fodder is exposed to the air, a loss of weight goes on, part of which is always dry matter.

Stook No.	10		9		8		7		6		5	
Date of Cutting	Nov. 7.		Nov. 23.		Dec. 17.		Jan. 12.		Feb. 7.		Feb. 23.	
	Total Weight. lbs.	Dry Matter. lbs.	Total Weight. lbs.	Dry Matter. lbs.	Total Weight. lbs.	Dry Matter. lbs.	Total Weight. lbs.	Dry Matter. lbs.	Total Weight. lbs.	Dry. Matter. lbs.	Total Weight. lbs.	Dry Matter. lbs
As harvested	3,018	652	3,360	726	3,052	659	3,015	681	2,835	641	2,880	651
As cut	1,614	570	1,529	642	1,786	667	1,860	580	1,155	471	1,202	431
Losses in stook	1,404	82	1,831	84	1,266	‡	1,155	101	1,680	170	1,678	220
Per cent losses in stook	46	13	55	12	41	‡	38	15	59	27	58	34
As cut	1,614	570	1,529	642	1,786	667	1,860	580	1,155	471	1,202	431
As fed	1,349	506	1,110	528	1,343	604	1,720	563	1,065	444	1,100	416
Losses while cut in pile	265	64	419	114	443	63	140	17	90	27	102	15
Per cent losses in pile	16	11	27	18	25	9	7	3	8	6	9	3
Days before finally fed out	16	....	24	....	26	....	26	....	16	....	17	....
Days from stooking	46	....	62	....	78	....	104	....	131	....	147	....

Stooks one to four are not included in the tabulation, because it is questionable whether they were kept strictly separate. The percentage of loss of dry matter increases with longer exposure. The losses from heating in the piled cut fodder decreased as the experiment went on, due probably to the colder weather of mid-winter. The apparent gain of dry matter in stook eight is at present unaccounted for. Owing to differences in husking in the field and at the stook the data is not at hand which will enable a similar comparison to be made with the corn stover. There is no reason to think, however that the results were materially different. There is a close relation between the losses of weight and of dry matter in the ensilages, as is well shown in the following table, which gives the figures for each layer of each ensilage.

KIND OF FODDER.	Loss of weight. lbs.	Loss of dry matter. lbs.	Dry matter lost for each 100 lbs of loss in weight. lbs.	Percentage loss of weight. per cent.	Percentage loss of dry matter. per cent.
Whole Ensilage, upper layer	1,437	435	30	15.2	21.3
Whole Ensilage, middle layer	1,582	508	32	18.1	25.7
Whole Ensilage, lower layer	1,627	424	26	13.3	15.9
Stover Ensilage, upper layer	1,127	351	31	13.4	20.2
Stover Ensilage, middle layer	1,472	379	26	18.6	22.2
Stover Ensilage, lower layer	1,428	403	28	12.4	16.6
Average..............	1,445	417	29	15.2	20.3

The experiment of two years ago showed an average of 25 pounds dry matter lost for each 100 pounds of loss in weight, an average percentage losses of weight and dry matter of 15.8 and 18.7, while the average of eight experiments at the Wisconsin Station show 19 per cent loss in both weight and dry matter. It would appear from these figures that, roughly, a fourth of the gross loss in the silo is dry matter, and that the percentage loss of dry matter usually exceeds that of the entire weight.

Is so large a loss inevitable? Experiments already reported seem to show that in rapid feeding from deep silos with small surface area will tend to reduce losses. From 2,965 pounds of ensilage put on the bottom of one of our silos in 1892, 2,876 pounds were fed out, a loss of but 3 per cent, the layer being put 7 feet square, 17½ inches deep, and fed out in two days in April.*

EFFECT ON THE EARS OF DIFFERENT METHODS OF PRESERVATION.

Do the ears lose more in feeding value when ensilaged than when picked? It will be remembered that the differences between "whole ensilage" and "stover ensilage and meal" in this experiment is simply that in one case the ears were cut into the silo with the stalks, and in the other they were husked, cribbed, dried, ground and fed. There is no reason for believing that the stalks of the whole ensilage and the stover ensilage, both put in equally good silos, kept any differently. It is fair to presume, and the analyses indicate, that they both lost the same amount of the same kind of feeding value. Whatever difference there is between the results is probably due to the different methods by which the ears were handled. The record of the dry matter of the various parts is as follows:

*Sixth Annual Report, p. 182.

Kind of Fodder.	Dry Matter.			
	Put in. lbs.	Taken out. lbs.	Loss. lbs.	Per cent of Loss.
Whole Ensilage	6,688	5,321	1,367	20
Stover Ensilage	5,865	4,731	1,134	19
Ears of Whole Ensilage	823	590	233	28
Ears of Stover Ensilage	868	780	88	10

There appears to have been much greater losses with the ears put into the silo than with those which were husked, the reverse of the results two years ago, when the losses were 15 per cent. with the ensilaged and 23 per cent. with the stooked ears. The stover ensilage ears of 1892, however, were exposed for several days to heavy rains, which probably accounts for their large losses. As will be noted in the next table, the ears of the other two parts lost but little in feeding value. The showing is not favorable to the ensilaged ears.

Do the ears cure on the stalks with as little loss as if picked?

Kind of Fodder.	Dry Matter.			
	Put in. lbs.	Taken out. lbs.	Loss. lbs.	Per cent of Loss.
Corn Fodder	6,688	5,339	1,349	20
Corn Stover	5,576	4,317	1,259	23
Ears of Corn Fodder	1,112	1,022	90	8
Ears of Corn Stover	1,156	1,058	98	9
Ears of Stover Ensilage	868	780	88	10

The table indicates but little difference in this respect.

RELATIVE COST.

If the ensilage is put in and fed without cutting, the stooks may be a little cheaper. If it is cut and it is expected to cut the fodder from time to time as needed, the labor and cost are largely in favor of the ensilage. In the present experiment, as well as in the previous and similar ones, it took but little less time and expense to stook the fodder near the barn than to cut it into the silo, while it took many times the trouble and cost to bring the fodder in, cut and feed it that it did to feed the cut ensilage from the silos. This is obviously even more true of the corn stover, since to this expense must be added that of husking, cribbing, grinding and cartage. The stover ensilage has the

advantage of the whole ensilage in that there is less material to ensilage (and less loss in the dry matter of the ears in the present experiment,) but the disadvantage of the expense of husking, cribbing, grinding and cartage. If it is true, as the experiments detailed in the sixth report, and, in part, in the present test, as well as others made elsewhere would indicate, that whole ensilage or corn fodder give as large or larger returns in milk and butter, there is, as stated in the sixth report, a "complete loss of all the labor and expense of the extra work of husking, etc. The usual charge in this State for husking is five cents a bushel, and it takes two bushel of ears to make a bushel of meal. The charge for grinding is from an eighth to a tenth of the meal, so that if meal is worth $20 a ton, the cost of husking and grinding will be 16 cents for each bushel of 56 pounds of cornmeal, without counting in the labor or expense of carrying to mill. This is more than a quarter of the total value of the meal, and according to the results of these experiments, is money and labor worse than wasted."

2. RESULTS OF FEEDING.

It was planned to test the feeding value of the corn plant preserved in these four ways with a herd of fourteen cows, divided into two groups of four cows, and two of three cows, feeding each group with one of the four parts of the fodder for four weeks, then shifting to another part with each group for a second four weeks, then shifting again until finally all were brought back on to the kind they had at the start, each group ending as they begun, so that the difference in the yield between the beginning and the end could be taken as the natural shrinkage occurring during the feeding test. After the experiment was fully under way and in the second feeding period, it became necessary to abandon the original plan. The corn fodder and corn stover was not sufficiently palatable to induce the cows to eat sufficient quantities to keep in flesh.

It will be remembered that the summer of 1894 was exceedingly dry. The rainfall at Burlington during the growing months of June, July and August and the first half of September was as follows:

June, - - - - - -	1.45 inches.
July, - - - - -	1.57 "
August, - - - - - -	1.49 "
September 1-15, - - - - -	1.70 "

Although harvested earlier than in previous years, many of the leaves were yellow and dry. The entire plant, however, contained more water than that harvested in 1892 or 1893, and the corn fodders and stovers as fed were more moist than those fed in the 1892-93 experiments, as shown by the following figures :

	Dry Matter Contained.		
	At Harvest.	In Corn Fodder as Fed.	In Corn Stover as Fed.
1892	22.92	47.03	45.18
1893	22.79	.....	.....
1894	22.19	41.44	42.54

The analyses of the dry matter of the average corn fodders and stovers of the two years are as follows:

	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Corn Fodder, 1892..........	6.73	9.50	26.05	55.21	2.51	1.520	0.551	1.689
Corn Fodder, 1894..........	8.88	9.04	27.32	52.47	2.27	1.448	0.384	1.652
Corn Stover, 1892...........	7.80	9.08	32.15	48.89	2.08	1.453	0.499	2.145
Corn Stover, 1894...........	9.75	8.57	29.91	49.83	1 94	1.374	0.338	1.758

The protein was about one-half per cent. less in this year's crop, the fiber a little more in the fodder and less in the stover. Chemistry does not show why the fodder was unpalatable, nor was its appearance inferior to that fed in previous years, except that it looked somewhat dryer, notwithstanding the fact that it was more moist. It is possible that the corn was actually less digestible because of the dry season, although we have no data to prove this. Whatever the cause, a large proportion of the cows under experiment ate too little of the dry fodder in comparison with the other materials fed to admit of safe conclusions being drawn, and the experiment was reluctantly remodeled. It is entirely safe to draw one conclusion, however, that both the whole and stover ensilages proved vastly superior in feeding value to either corn fodder or stover in this particular experiment. The remodeled experiment divided the cows into two sets of two groups each.

Set. 1. Six cows, divided into two groups of three each, were fed for five four-week periods on the ensilages alternating from period to period, closing the test on the same ensilage as was fed at the start.

Set 2. Eight cows, divided into two groups of four each, were fed for five four-week periods on the dry fodders.

All weights and analyses were made and the data worked out for both sets, but for the reasons already given, it is not thought safe to lay any stress on the results obtained from Set 2. The ensilage side of the test went through very successfully, none of the cows being off feed at any time, and all eating the ensilages readily. Each cow was fed four pounds of wheat bran and four pounds of corn meal daily, given in two equal feeds morning and night. They were also fed ten pounds of fine early cut hay containing much clover in two equal feeds. The grain and the hay were fed the first thing morning and evening, and after that had been eaten up the cow was given all she would eat of the particular kind of ensilage she was receiving during that period. Thus all the orts belonged to the experimental fodder. The amount given to the cow was weighed and the orts were weighed back daily. The cows were not fed at noon; they had water twice a day.

Each milking was weighed. The first ten days of each period was considered preparatory, then the milk for the next six days was analyzed and also for the last six days of the period. The intervening six days' milk was considered to have the same composition as the average of the six days preceding and following, these eighteen days being taken as the experimental period. Records were kept, however, of all material fed and milk given during the ten days preparatory period, as well as the eighteen days experimental period. The cows were weighed for three successive days at the beginning and end of each feeding period.

COWS USED IN THE EXPERIMENT.

GROUP A.	Age.	Calved.	Served.	Live Weight at Beginning of Test.
Nancy B.	8	about Sept. 15	Oct. 20	932
Dandelion	6	Sept. 23	Jan. 15	737
Maizie	9	June 18	Oct. 29	850
GROUP B.				
Atalanta	5	Oct. 30	....	741
Golden Rod	3	Oct. 5	March 22	836
Red Top	6	about April 1	Jan. 20	842

Nancy B and Atalanta are registered Ayrshires, the other four are high grade Jerseys.

FEEDING PERIODS AND FODDERS FED EACH GROUP.

Period Number.	Dates of Periods.	Group A.	Group B.
I	Dec. 5–Jan. 2	Stover ensilage and meal.	Whole ensilage.
II	Jan. 2–Jan. 30	Whole ensilage.	Stover ensilage and meal.
III	Jan. 30–Feb. 27	Stover ensilage and meal.	Whole ensilage.
IV	Feb. 27–March 27	Whole ensilage.	Stover ensilage and meal.
V	March 27–April 24	Stover ensilage and meal.	Whole ensilage.

WEIGHTS OF COWS.

All the cows under experiment were weighed the first three days of the opening period, and the last three days of all periods. The average weights are as follows:

Name of Cow. Period	I	I	II	III	IV	V
Nancy B, - - -	935	945	918	945	955	965
Dandelion, - - - -	748	755	750	750	751	755
Maizie, - - - -	872	882	875	853	863	893
Atalanta, - - - -	752	757	754	758	775	797
Golden Rod, - - -	852	857	865	868	875	890
Red Top, - - - -	862	882	865	855	860	855

Dandelion's weight remained uniform, Atalanta and Golden Rod gained in weight, Nancy B and Maizie, on the whole gained in weight, although fluctuating from time to time, while Red Top barely held her own. There is no particular effect of varying rations to be observed in any case.

YIELDS OF MILK, ETC.

The test lasted 140 days with six cows, or the equivalent of 420 days feed from each ensilage for one cow. The first ten days of each period were considered preliminary, the final eighteen experimental. The following table shows the total yields for the final eighteen days equivalent to the product of one cow for 270 days.

	Milk.	Total Solids.	Fat.	Solids not fat.
	lbs.	lbs.	lbs.	lbs.
Whole Ensilage, - -	5,403	754	257	497
Stover Ensilage and Meal, -	5,440	757	257	500

Had the cows been fed precisely alike the results could have hardly been closer. The butter yields are identical, and there is but one-half of one per cent. difference in the milk yields.

In the trials two years ago the stover ensilage and meal ration produced from a thirtieth to a fortieth less milk and butter than whole ensilage, while at the Wisconsin Station* practically identical results were obtained from each method. It seems fair to conclude that there is little if anything gained by picking the ears before ensilaging.

QUALITY OF MILK.

The quality of the milk given by the six cows on these fodders was very even, being:

	Total Solids.	Fat.	Solids not fat.
Whole Ensilage - - -	13.96	4.76	9.20
Stover Ensilage and Meal, - -	13.92	4.73	9.19

This is likewise in accord with the results of the former trial.

In this connection, although not strictly germane to the subject, it may be stated that the milk of the cows fed corn fodder and corn stover and meal was unaffected in quality by the changes in the rations, being:

	Total Solids.	Fat.	Solids not fat.
Corn Fodder, - - -	14.69	5.23	9.46
Corn Stover and Meal, - -	14.71	5.25	9.46

Also that changes from an ensilage to a fodder or stover ration, or the reverse, in the outset of the experiment produced no material changes in the milk of twelve cows.

There was fed daily to each cow 10 pounds fine early cut hay and four pounds each of wheat bran and corn meal in addition to and before the experimental fodders. The total amount fed these six cows during the eighteen days experimental period was 5,400 pounds hay and 2,160 pounds of bran and 2,160 pounds of corn meal, containing 8,329 pounds of dry matter equally distributed among periods and cows. The following table shows the amount of total dry matter eaten in the rations, the dry matter eaten derived from the experimental fodders and the average of each eaten daily per cow during the experimental periods.

*Ninth Annual Report Wisconsin Experiment Station, p. 65.

DRY MATTER EATEN.

KIND OF FODDER.	In entire ration. lbs.	Average amount daily per cow. lbs.	In experimental fodder. lbs.	Average amount daily per cow. lbs.
Whole Ensilage............	5,856	21.7	1,691	6.26
Stover Ensilage and Meal...	6,082	22.5	1,918	7.10

Combining the data of the last table and the one showing the yields of milk and milk products we have a table showing the relative efficiency of the two ensilages.

RELATIVE YIELDS FROM EQUAL AMOUNTS OF DRY MATTER IN ENTIRE RATIONS AND EXPERIMENTAL ENSILAGES.

IN ENTIRE RATION.	YIELD PRODUCED FOR EACH 100 POUNDS OF DRY MATTER.			
	Milk.	Total Solids.	Fat.	Solids not fat.
Whole Ensilage..........	92.3	12.87	4.39	8.48
Stover Ensilage and Meal.	89.5	12.45	4.22	8.23

IN EXPERIMENTAL ENSILAGES.	YIELD PRODUCED FOR EACH 100 POUNDS OF DRY MATTER.			
	Milk.	Total Solids.	Fat.	Solids not fat.
Whole Ensilage..........	319.5	44.60	15.21	29.39
Stover Ensilage and Meal.	283.6	39.47	13.24	26.23

The most striking result brought out by the experiment of two years ago was that "though producing equal quantities of milk, they (the cows) ate much less of the whole ensilage to produce this milk than they did of any of the other fodders. For each 100 pounds of dry matter of the whole ensilage eaten, the cows ate 119 pounds of dry matter in the stover ensilage, 109 pounds from the

corn fodder and 127 pounds of dry matter from the corn stover. The two ensilages required 110 pounds as compared with 113 pounds from the two stooked fodders; the portions where the corn was ground and fed as meal took 123 pounds as compared with but 105 pounds where no husking or grinding took place."

Essentially the same yields of milk and butter were produced from these various amounts of food eaten.

The present experiment shows the same thing again, a decided difference in the amount of dry matter eaten in favor of the whole ensilage. Five out of the six cows ate less dry matter from the whole ensilage in each feeding period than the least amount they ate in any period when on stover ensilage.

The amounts of milk, solids and fat, produced by 100 pounds of dry matter in the entire rations stand in the ratio of *whole ensilage*, 100, *stover ensilage and meal*, 96. The amounts of milk, solids and fat produced, considering the dry matter of the experimental ensilages only, standing in the ratio of *whole ensilage*, 100, *stover ensilage and meal*, 89 (*milk, solids and solids not fat*) *and* 87 (*fat*). It is but fair to say, however, that this striking difference, twice observed on two entirely different herds at this Station, was not found in the similar experiment at the Wisconsin Station, where the experimental ensilages made up a larger part of the ration than they did in our trials.

TOTAL YIELDS.

It is fair to presume that had all of the crop been fed under the conditions of the experimental periods it would have produced milk and butter proportionately. If this is true *the* 5,321 *pounds of dry matter saved ready for feeding in the whole ensilage should have produced* 17,002 *pounds of milk and* 809 *pounds of fat, and the* 5,512 *pounds of dry matter saved ready for feeding in the stover ensilage and meal should have produced*, 15,635 *pounds of milk and* 739 *pounds of fat, provided the hay and grain rations were fed in proportionately increased amounts*. Expressing this on the scale of 100, for every 100 pounds of milk and fat produced by the whole ensilage ration, 92 and 91 pounds of milk and fat respectively would have been produced by the stover ensilage and meal ration.

The whole ensilage lasted longer than the stover ensilage. At the end of the feeding tests there was 17 per cent of the whole ensilage left, and but 10 per cent of the stover ensilage. The relative amounts of dry matter left were also 17 and 10 per cent of the whole taken out. Had the feeding continued under similar conditions and at the same rate as before until the stover ensilage and meal were fed out there would have been 9 per cent of the dry matter and entire weight of the whole ensilage still on hand. In other words **1.00** acre of corn made into whole ensilage produced when fed as much milk and butter as **1.095** acres of corn made into stover ensilage and meal. The figures obtained in the experiment of two years ago were 1.00 and 1.26 respectively. If we consider also the additional expense of husking, drying and grinding, there is still less to recommend the stover ensilage and meal.

SUMMARY.

1. Each of the four methods of preservation saved about four-fifths of the dry matter as harvested, and, judged by this alone, were of practically equal efficiency, the figures being: Stover ensilage and meal, 18 per cent. loss of dry matter, whole ensilage, corn fodder and corn stover and meal, 20 per cent. loss of dry matter each. These figures are almost identical with those obtained in similar tests previously made at this Station.

2. The character of the losses in food ingredients is much the same in each case, there being little or no loss of crude ash or crude fiber, a shortage of about a tenth each of the crude protein, phosphoric acid and potash, while ether extract and nitrogen-free extract lose respectively two-tenths and three-tenths of the amount present at harvest.

3. The stooked fodders, while stooked, lost more and more dry matter as the winter went on; after cutting they lost considerable dry matter, but less as the winter grew longer.

4. The losses in gross weight and dry matter in the silos were found to be parallel, the latter, however, exceeding the former.

5. The ears in the silo lost more of their food value than those handled in other ways, the reverse of the result in the 1892-93 experiment.

6. The relative cost of placing the same amount of dry matter in the manger was greatly in favor of the whole ensilage. The time and money spent in husking and grinding the ears was wasted, since better results were obtained when the ears were left on the stalk.

7. In this experiment the ensilages were relished much better than the dry fodders, and the cows did better upon them.

8. The same quantities of milk and butter were made by feeding whole ensilage and stover ensilage and meal; the milk was not changed in quality; but the cows ate less dry matter from whole ensilage to produce the same amounts of milk and butter.

9. There were but 91 or 92 pounds of milk and butter produced by a given amount of dry matter in the stover ensilage and meal ration to 100 pounds produced by the same amount of dry matter in the whole ensilage ration.

10. The whole ensilage lasted longest, and would consequently make the most milk and butter. An acre of corn made into whole ensilage yielded as much as 1.095 acres made into stover ensilage.

11. The results of this experiment as a whole are in entire accord with those obtained in the similar trial at this Station in 1892-93, published in the sixth report, pages 163-197.

3. RECORDS OF THE TESTS.

I.—AVERAGE ANALYSES OF CROP, AND ITS VARIOUS PARTS AS HARVESTED AND AS FED.

COMPOSITION AT HARVEST AS SHOWN BY ANALYSES OF THE ENTIRE PLANT AND BY CALCULATIONS FROM THE ANALYSES OF THE VARIOUS PARTS.

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Upper Layer.										
Whole ensilage	78.40	21.60	7.42	8.23	21.12	60.69	2.54	1.317	0.352	1.473
Stover ensilage, husks and ears	77.89	22.11	7.36	8.22	20.55	61.39	2.48	1.314	0.322	1.559
Latter ± former	.....	+0.51	−0.06	−0.01	−0.57	+0.70	−0.06	−.003	−.030	+.086
Percentage—	.....	2.4	0.8	0.1	2.7	1.1	2.4	0.3	8.5	5.9
Middle Layer.										
Whole ensilage	77.40	22.60	7.10	8.16	21.64	60.85	2.25	1.306	0.353	1.341
Stover ensilage, husks and ears	77.15	22.85	7.05	7.94	21.98	60.64	2.39	1.270	0.321	1.310
Latter ± former	.....	+0.25	−0.05	−0.22	+0.34	−0.21	+0.14	−.036	−.032	−.031
Percentage—	.....	1.1	0.7	2.7	1.6	0.3	6.2	2.8	9.1	2.3
Lower Layer.										
Whole ensilage	78.09	21.91	7 00	8.23	20.87	61.38	2.52	1.317	0.377	1.468
Stover ensilage, husks and ears	77.72	22.28	6 86	8.01	20.43	62 43	2.27	1 282	0.340	1.499
Latter ± former	.....	+0 37	−0.14	−0.22	−0.44	+1 05	−0.25	−.041	−.037	+.031
Percentage—	.....	1.7	2.0	2.7	2.1	1.7	10.0	3.1	9.7	2.1
Stover ensilage (without husks) — Upper layer	79.50	20.50	8 64	7.78	23.10	58.15	2.33	1.245	0.316	1.732
Stover ensilage (without husks) — Middle layer	78.38	21.62	7.89	7.87	23.79	59.40	2.22	1.259	0.304	1.389
Stover ensilage (without husks) — Lower layer	78.98	21.02	7.70	7.81	22.03	60.42	2.04	1.250	0.315	1.609
Husks — Upper layer	79.74	20.26	3.92	5.53	21.67	66.28	2.60	0.885	0.177	1.100
Husks — Middle layer	77.90	22.10	4.49	6.12	22.13	64.13	3.13	0.980	0.353	1.359
Husks — Lower layer	76.98	23.02	3.30	5.69	22.32	66.17	2.52	0.911	0.324	1.250
Ears, — Upper layer	60.18	39.82	1.49	11.36	6.51	76.36	4.28	1.818	0.416	0.710
Ears, — Middle layer	62.01	37.99	2.20	9.02	10.09	74.79	3.90	1.443	0 432	0.766
Ears, — Lower layer	61.78	38.22	2.14	10.22	8.35	74.83	4.46	1.635	0.523	0.800

AVERAGE ANALYSES OF ENTIRE PLANT AS HARVESTED AND WHEN ENSILAGED OR STOOKED.

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Upper Layer.										
As harvested	78.40	21.60	7.42	8.23	21.12	60.69	2.54	1.317	0.352	1.473
Whole ensilage as fed	79.96	20.04	10.36	9.18	24.98	53.03	2.45	1.467	0.368	1.860
Stover ensilage, with husks and ears as fed	78.17	21.83	10.82	10.00	23.61	52.81	2.76	1.604	0.409	1.971
Corn fodder as fed	56.94	43.06	9.44	10.80	30.05	47.94	2.27	1.643	0.422	1.998
Corn stover and ears as fed	53.24	46.76	7.93	9.72	23.67	56.27	2.41	1.550	0.412	1.691
Middle Layer.										
As harvested	77.40	22.60	7.10	8.16	21.64	60.85	2.25	1.306	0.353	1.341
Whole ensilage as fed	79.51	20.49	8.80	9.48	25.97	53.31	2.44	1.515	0.403	1.904
Stover ensilage with husks and ears as fed	76.90	23.10	7.19	8.86	23.90	57.29	2.76	1.418	0.345	1.418
Corn fodder as fed	63.38	36.62	8.44	8.84	26.40	54.10	2.22	1.412	0.401	1.468
Corn stover and ears as fed	50.55	49.45	8.04	9.20	24.77	55.63	2.36	1.472	0.379	1.439
Lower Layer.										
As harvested	78.09	21.91	7.00	8.23	20.87	61.38	2.52	1.317	0.377	1.468
Whole ensilage as fed	78.73	21.27	8.83	8.70	25.25	54.44	2.78	1.393	0.360	1.800
Stover ensilage with husks and ears as fed	77.77	22.23	8.54	9.00	24.80	55.33	2.33	1.442	0.368	1.541
Corn fodder as fed	56.13	43.87	8.75	8.30	25.91	54.76	2.28	1.333	0.351	1.517
Corn stover and ears as fed	53.20	46.80	8.81	8.44	28.05	52.45	2.25	1.350	0.376	1.486
Average.										
As harvested	77.81	22.19	7.30	8.21	21.17	60.87	2.45	1.312	0.362	1.421
Whole ensilage as fed	79.29	20.71	9.29	9.06	25.35	53.71	2.59	1.451	0.374	1.848
Stover ensilage with husks and ears as fed	77.67	22.33	8.85	9.27	24.19	55.11	2.58	1.484	0.376	1.637
Corn fodder as fed	58.56	41.44	8.88	9.04	27.32	52.47	2.27	1.448	0.384	1.652
Corn stover and ears as fed	52.43	47.57	8.30	9.00	25.75	54.62	2.33	1.442	0.389	1.533

AVERAGE ANALYSES OF CORN STOVERS, AS HARVESTED AND WHEN ENSILAGED OR STOOKED.

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Upper Layer.										
Ensilaged stover with husks as harvested.	79.51	20.49	8.40	7.66	23.03	58.56	2.35	1.226	0.305	1.699
Stooked stover with husks as harvested.	80.09	19.89	8.83	7.42	24.06	57.66	2.02	1.187	0.302	1.766
Stover ensilage with husks as fed.......	81.16	18.84	12.59	9.73	26.79	48.38	2.51	1.557	0.371	2.231
Corn stover as fed......................	59.69	40.31	9.91	9.20	28.90	49.99	2.00	1.467	0.359	2.054
Middle Layer.										
Ensilaged stover with husks as harvested	78.36	21.64	7.73	7.78	23.65	58.58	2.26	1.246	0.306	1.387
Stooked stover with husks as harvested.	78.98	21.02	8.11	7.71	24.58	57.53	2.06	1.238	0.300	1.430
Stover ensilage with husks as fed.......	79.30	20.70	7.89	8.61	26.60	54.35	2.55	1.376	0.316	1.[illegible]57
Corn stover as fed......................	55.26	44.74	9.37	8.70	28.51	51.41	2.01	1.394	0.336	1.648
Lower Layer.										
Ensilaged stover with husks as harvested	78.89	21.11	7.48	7.71	22.04	60.71	2.06	1.232	0.315	1.591
Stooked stover with husks as harvested.	79.19	20.81	7.66	7.63	22.47	60.33	1.81	1.227	0.314	1.611
Stover ensilage with husks as fed.......	79.90	20.10	9.37	8.83	26.91	52.79	2.10	1.414	0.331	1.640
Corn stover as fed......................	57.42	42.58	9.94	8.06	31.65	48.50	1.86	1.291	0.326	1.635
Average.										
Ensilaged stover with husks as harvested	78.90	21.10	7.93	7.71	22.90	59.22	2.24	1.233	0.308	1.573
Stooked stover with husks as harvested.	79.41	20.59	8.12	7.59	23.55	58.75	1.99	1.217	0.305	1.607
Stover ensilage with husks as fed.......	80.13	19.87	9.90	9.03	26.81	51.91	2.35	1.445	0.338	1.788
Corn stover as fed......................	57.46	42.54	9.75	8.57	29.91	49.83	1.94	1.374	0.338	1.758

NOTE.—Owing to differences in weights of ears obtained by rapid picking off in field from rows subsequently made into stover ensilage and of those obtained by careful husking of the stooks, the analyses of " ensilaged stover with husks as harvested" and "stooked stover with husks as harvested " differ slightly.

AVERAGE ANALYSES OF EARS AT HARVEST AND COB MEALS.

	Original Substance.		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
Upper Layer.										
Ears as harvested......................	60.12	39.88	1.49	11.36	6.51	76.36	4.28	1.818	0.416	0.710
Cob meal (stover ensilage).............	9.76	90.24	2.31	11.29	8.40	74.03	3.97	1.807	0.590	0.720
Cob meal (corn stover).................	8.18	91.82	1.86	11.33	7.60	75.51	3.70	1.813	0.566	0.573
Middle Layer.										
Ears as harvested......................	62.01	37.99	2.20	9.02	10.09	74.79	3.90	1.443	0.432	0.766
Cob meal (stover ensilage).............	9.84	90.16	2.77	10.44	6.50	76.17	4.12	1.670	0.597	0.608
Cob meal (corn stover).................	8.23	91.77	2.17	11.42	8.40	74.13	3.88	1.827	0.573	0.540
Lower Layer.										
Ears as harvested......................	61.78	38.22	2.14	10.22	8.35	74.83	4.46	1.635	0.523	0.800
Cob meal (stover ensilage).............	9.74	90.26	2.62	10.21	9.69	73.50	3.98	1.634	0.628	0.840
Cob meal (corn stover).................	7.96	92.04	3.19	10.39	10.21	72.19	4.02	1.662	0.617	0.742
Average.										
Ears as harvested......................	61.74	38.26	1.99	10.28	8.18	75.32	4.23	1.649	0.456	0.759
Cob meal (stover ensilage).............	9.77	90.23	2.55	10.67	8.37	74.41	4.00	1.707	0.603	0.718
Cob meal (corn stover).................	8.08	91.92	2.36	11.06	8.70	74.00	3.88	1.770	0.595	0.614

II.—LOSSES OF FOOD INGREDIENTS BY THE VARIOUS METHODS OF PRESERVATION.

WHOLE CORN ENSILAGE.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Upper Layer.											
As harvested	9430.	7393.1	2036.9	151.1	167.6	430.2	1236.3	51.7	26.8	7.2	30.0
Ensilage as fed	7993	6391.1	1601.9	166.0	147.1	400.1	849.5	39.2	23.5	5.9	29.8
Losses, field to manger	1437	1002	435.	+14.9	24.5	30.1	300.8	12.5	3.3	1.3	0.2
Pr. ct. of losses, field to manger	15.2	13.6	21.3	+	12.2	7.0	31.3	24.2	12.3	18.1	0.7
Middle Layer.											
As harvested	8730.	6757.	1973.	140.1	161.0	427.0	1200.5	44.4	25.8	7.1	26.5
Ensilage as fed	7148	5683.2	1464.8	128.9	138.9	380.4	780.9	35.7	22.2	5.9	27.9
Losses, field to manger	1582	1073.8	508.2	11.2	22.1	46.6	419.6	8.7	3.6	1.2	+1.4
Pr. ct. of losses, field to manger	18.1	15.9	25.7	7.9	13.7	10.9	35.0	19.6	14.0	16.9	+
Lower Layer.											
As harvested	12225.	9546.5	2678.5	187.5	220.4	559.0	1644.1	67.5	35.3	10.1	39.3
Ensilage as fed	10598	8344.1	2254.2	199.1	196.1	569.0	1297.4	62.6	31.4	8.1	40.6
Losses, field to manger	1627	1202.4	424.3	+11.6	24.3	+10.0	416.7	4.9	3.9	2.0	+1.3
Pr. ct. of losses, field to manger	13.3	12.6	15.9	+	11.1	+	25.4	7.2	11.0	20.0	+
Total.											
As harvested	30385	23697	6688	479	549	1416	4080	164	87.9	24.4	95.8
Ensilage as fed	25739	20418	5321	494	482	1349	2858	138	77.1	19.9	98.3
Losses, field to manger	4646	3279	1367	+15	67	67	1222	26	10.8	4.5	2.5
Pr. ct. of losses, field to manger	**15.3**	**13.8**	**20.4**	**+**	**12.2**	**4.7**	**30.**	**15.9**	**12.3**	**18.4**	**+**

STOVER ENSILAGE (WITH HUSKS) AND EARS.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Upper Layer.											
As harvested	9190	7158	2032	149.6	167.0	417.6	1247.4	50.4	26.7	6.5	31.6
Ensilage as fed	7622	5958.2	1663.8	180	166.4	392.8	878.7	45.9	26.7	6.8	32.8
Losses, field to manger	1568	1199.8	368.2	+30.4	0.6	24.8	368.7	4.5	0.0	+0.3	+1.2
Percent of losses, field to manger	17.1	16.7	18.1	+	0.4	5.9	29.6	9.0	0.0	+	+
Middle Layer.											
As harvested	8529	6580.1	1948.9	137.4	154.8	428.4	1181.7	46.6	24.8	6.3	25.5
Ensilage as fed	6656	5118.7	1537.3	110.6	136.1	367.4	880.8	42.4	21.8	5.4	21.8
Losses, field to manger	1873	1461.4	411.6	26.8	18.7	61.0	300.9	4.2	3.0	0.9	3.7
Percent of losses, field to manger	21.9	22.2	21.1	19.5	12.1	14.3	25.4	9.0	12.1	14.3	14.5
Lower Layer.											
As harvested	12349	9597.8	2751.2	188.7	220.4	562.0	1717.7	62.4	35.3	9.4	41.2
Ensilage as fed	10393	8082.6	2310.4	197.2	207.9	572.9	1278.6	53.8	33.3	8.5	35.6
Losses, field to manger	1956	1515.2	440.8	+8.5	12.5	+10.9	439.1	8.6	2.0	0.9	5.6
Percent of losses, field to manger	15.8	15.8	16.0	+	5.7	+	25.6	13.8	5.6	9.6	13.8
Total.											
As harvested	30068	23336	6732	475	542	1408	4148	159	86.8	22.2	98.3
Ensilage as fed	24671	19159	5512	488	511	1333	3038	142	81.8	20.7	90.2
Losses, field to manger	5397	4177	1220	+13	31	75	1110	17	5.0	1.5	8.1
Percent of losses, field to manger	**18.0**	**17.9**	**18.1**	**+**	**5.7**	**5.3**	**26.7**	**10.7**	**5.8**	**6.8**	**8.2**

STOVER ENSILAGE (WITH HUSKS.)

	Total Weight. lbs.	Water. lbs.	Dry Matter. lbs.	Crude Ash. lbs.	Crude Protein. lbs.	Crude Fibre. lbs.	Nitrogen—Free Extract. lbs.	Ether Extract. lbs.	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash. lbs.
Upper Layer.											
As harvested	8429	6701.9	1727.1	145.0	132.3	397.7	1011.5	40.6	21.2	5.3	29.4
Ensilage as fed	7302	5926.2	1375.8	173.3	133.9	368.6	665.5	34.5	21.4	5.1	30.7
Losses, field to manger	1127	775.7	351.3	+28.3	+1.6	29.1	346.0	6.1	+0.2	0.2	+1.3
Percent of losses, field to manger	13.4	11.6	20.2	+	+	7.3	34.2	15.0	+	3.8	+
Middle Layer.											
As harvested	7898	6188.9	1709.1	132.2	133.0	404.2	1001.1	38.6	21.3	5.2	23.7
Ensilage as fed	6426	5095.7	1330.3	104.9	114.5	353.9	723.1	33.9	18.3	4.2	20.7
Losses, field to manger	·1472	1093.2	378.8	27.3	18.5	50.3	278.0	4.7	3.0	1.0	3.0
Percent of losses, field to manger	18.6	17.7	22.2	20.7	13.9	12.4	27.8	12.2	14.1	19.2	12.7
Lower Layer.											
As harvested	11504	9075.5	2428.5	181.7	187.2	535.2	1474.2	50.0	29.9	7.7	38.6
Ensilage as fed	10076	8050.6	2025.4	189.7	178.8	545.0	1068.4	42.5	28.6	6.7	33.2
Losses, field to manger	1428	1024.9	403.1	+8.0	8.4	+9.2	405.8	7.5	1.3	1.0	5.4
Percent of losses, field to manger	12.4	11.3	16.6	+	4.5	+	27.5	15.0	4.3	13.0	14.0
Total.											
As harvested	27831	21966	5865	459	453	1337	3487	129	72.4	18.2	91.7
Ensilage as fed	23804	19073	4731	468	427	1268	2457	111	68.3	16.0	84.6
Losses, field to manger	4027	2893	1134	+9	26	69	1030	18	4.1	2.2	7.1
Percent of losses, field to manger	14.5	13.2	19.4	+	5.8	5.1	29.5	13.8	5.6	12 1	7.7

EARS OF STOVER ENSILAGE.

	Total Weight. lbs.	Water. lbs.	Dry Matter. lbs.	Crude Ash. lbs.	Crude Protein. lbs.	Crude Fibre. lbs.	Nitrogen—Free Extract. lbs.	Ether Extract. lbs.	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash. lbs.
Upper Layer.											
As harvested	761	456	305	4.6	34 7	19.9	232.7	13.1	5.5	1.2	2.2
Meal as fed	320	32	288	6.7	32.5	24 2	213.2	11.4	5.2	1.7	2.1
Losses, field to manger	441	424	17	+2.1	2.2	+4.3	19.5	1.7	0.3	+0.5	0.1
Percent of losses, field to manger	58	93	5.6	+	6.3	+	8.4	13.0	5 4	+	4.6
Middle Layer.											
As harvested	631	391.3	239.7	5.3	21.6	24 2	179.3	9.3	3.5	1.0	1.8
Meal as fed	230	23	207.0	5.7	21.6	13.5	157.7	8.5	3.5	1.2	1.1
Losses, field to manger	401	368.3	32.7	+0.4	0.0	10.7	21.6	0.8	0.0	+0.2	0.7
Percent of losses, field to manger	63.5	94.1	13.5	+	0.0	44.2	12.0	8.6	0.0	+	38.9
Lower Layer.											
As harvested	845	522	323	6.9	33.0	27.0	241.7	14.4	5.3	1.7	2.6
Meal as fed	317	32	285	7.5	29.1	27.6	209.5	11.3	4.7	1.8	2.4
Losses, field to manger	528	490	38	+0.6	3.9	+0.6	32.2	3.1	0 6	+0.1	0.2
Percent of losses, field to manger	62.5	93.9	11.8	+	11.8	+	13.3	21.4	11.3	+	7.7
Total.											
As harvested	2237	1369	868	17	89	71	654	37	14.3	3.9	6.6
Meal as fed	867	87	780	20	83	65	581	31	13.4	4.7	5.6
Losses, field to manger	1370	1282	88	+ 3	6	6	73	6	0.9	+0.8	1.0
Percent of losses, field to manger	62 1	93.7	10.1	+	6.7	8.4	11.2	16.2	6.3	+	15.2

CORN FODDER.

	Total Weight. lbs.	Water. lbs.	Dry Matter. lbs.	Crude Ash. lbs.	Crude Protein. lbs.	Crude Fibre. lbs.	Nitrogen—Free Extract. lbs.	Ether Extract. lbs.	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash. lbs.
Upper Layer.											
As harvested	9430	7393.1	2036.9	151.1	167.6	430.2	1236.3	51.7	26.8	7.2	30.0
Fodder as fed	3082	2165.	1637.	154.6	168.5	491.9	784.8	37.2	26.9	6.9	32.7
Losses, field to manger	5628	5228.1	399.9	+3.5	+0.9	+61.7	451.5	14.5	+0.1	0.3	+2.7
Percent of losses, field to manger	59.7	70.7	19.6	+	+	+	36.5	28.0	+	4.7	+
Middle Layer.											
As harvested	8730	6757	1973	140.1	161.0	427.0	1200.5	44.4	25.8	7.1	26.5
Fodder as fed	3885	2462.2	1422.8	120.1	125.8	375.8	769.5	31.6	20.1	5.7	20.9
Losses, field to manger	4845	4294.8	550.2	20.0	35.2	51.2	431.0	12.8	5.7	1.4	5.6
Percent of losses, field to manger	55.4	63.6	27.9	14.3	21.8	12.0	35.9	28.8	22.1	19.7	21.1
Lower La yer.											
As harvested	12225	9546.5	2678.5	187.5	220.4	559.0	1644.1	67.5	35.3	10.1	39.3
Fodder as fed	5196.	2916.7	2279.3	199.4	189.1	590.8	1248.0	52.0	30.3	7.9	34.6
Losses, field to manger	7029.	6629.8	399.2	+11.9	31.3	+31.8	396.1	15.5	5.0	2.2	4.7
Percent of losses, field to manger	57.5	69.5	14.9	+	14.2	+	24.1	23.0	14.2	21.7	12.0
Total.											
As harvested	30385	23697	6688	479	549	1416	4080	164	87.9	24.4	95.8
Fodder as fed	12883	7544	5339	474	483	1459	2802	121	77.3	20.5	88.2
Losses, field to manger	17502	16153	1349	5	66	+43.	1278	43	10.6	3.9	7.6
Percent of losses, field to manger	57.6	68.2	20.2	1.0	12.0	+	31.3	26.2	12.0	16.0	7.9

CORN STOVER (WITH HUSKS) AND EARS.

	Total Weight. lbs.	Water. lbs.	Dry Matter. lbs.	Crude Ash. lbs.	Crude Protein. lbs.	Crude Fibre. lbs.	Nitrogen—Free Extract. lbs.	Ether Extract. lbs.	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash. lbs.
Upper Layer.											
As harvested	9190	7158	2032	149.6	167.0	417.6	1247.4	50.4	26.7	6.5	31.6
Stover, etc., as fed	3478	1851.7	1626.3	129.0	158.0	384.9	915.2	39.2	25.2	6.7	27.5
Losses, field to manger	5712	5306.3	405.7	20.6	9.0	32.7	332.2	11.2	1.5	+0.2	4.1
Percent of losses, field to manger	62.2	74.0	19.9	13.8	5.4	7.8	26.6	22.0	5.7	+	13.0
Middle Layer.											
As harvested	8529	6580.1	1948.9	137.4	154.8	428.4	1181.7	46.6	24.8	6.3	25.5
Stover, etc., as fed	3331	1683.7	1647.3	132.4	151.5	407.9	916.6	38.9	24.2	6.3	23.7
Losses, field to manger	5198	4896.4	301.6	5.0	3.3	20.5	265 1	7.7	0.6	0.0	1.8
Percent of losses, field to manger	60.8	74.4	15.4	3.6	2.1	4.8	22.4	16.5	2.5	0.0	7.1
Lower Layer.											
As harvested	12349	9597.8	2751.2	188.7	220.4	562.0	1717.7	62.4	35.3	9.4	41.2
Stover, etc., as fed	4490	2388.6	2101.4	185.1	177.4	589.5	1102.1	47.3	28.4	7.9	31.2
Losses, field to manger	7859	7209.2	649.8	3.6	43.0	+27.5	615.6	15.1	6.9	1.5	10.0
Percent of losses, field to manger	63.6	75.1	23.6	2.0	19.5	+	35.8	24.2	19.8	16.0	24.3
Total.											
As harvested	30068	23336	6732	475	542	1408	4148	159	86.8	22.2	98.3
Stover, etc., as fed	11299	5924	5375	446	487	1383	2934	125	77.8	20.9	82.4
Losses, field to manger	18769	17412	1357	29	55	25	1214	34	9.5	1.3	15.9
Percent of losses, field to manger	62.4	74.6	20.0	6.1	10.2	1.7	29.3	21.4	10.9	5.9	16.2

CORN STOVER (WITH HUSKS).

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether extract.	Nitrogen.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Upper Layer.											
As harvested	8169	6543.6	1625.4	143.5	120.7	391.1	937.2	32.9	19.3	4.9	28.7
Stover as fed	3044	1817	1227	121.6	112.8	354.6	613.5	24.5	18.0	4.4	25.2
Losses, field to manger	5125	4726.6	398.4	21.9	7.9	36.5	323.7	8.4	1.3	0.5	3.5
Percent losses, field to manger	62.7	72.2	24.5	15.2	6.5	9.4	34.6	25.5	6.7	10.0	12.2
Middle Layer.											
As harvested	7608	6009	1599	129.7	123.3	393.1	919.9	33.0	19.8	4.8	22.9
Stover as fed	2997	1656.2	1340.8	125.7	116.5	382.2	689.4	27.0	18.7	4.5	22.1
Losses, field to manger	4611	4352.8	258.2	4.0	6.8	10.9	230.5	6.0	1.1	0.3	0.8
Percent losses, field to manger	60.6	72.4	16.1	3.1	5.5	2.8	25.1	18.2	5.5	6.3	3.5
Lower Layer.											
As harvested	11305	8952.8	2352.2	180.2	179.6	528.7	1419.1	44.6	28.8	7.3	38.0
Stover as fed	4107	2358.1	1748.9	173.9	140.9	553.5	848.1	32.5	22.6	5.7	28.6
Losses, field to manger	7198	6594.7	603.3	6.3	38.7	+24.8	571.0	12.1	6.2	1.6	9.4
Percent of losses, field to manger	63.6	73.7	25.6	3.5	21.6	+	42.3	27.1	21.6	22.0	24.7
Total.											
As harvested	27082	21506	5576	453	423	1313	3276	111	67.9	17.	89.6
Stover as fed	10148	5831	4317	421	370	1291	2151	84	59.3	14.6	75.9
Losses, field to manger	16934	15675	1259	32	53	22	1125	27	8.6	2.4	13.7
Percent of losses, field to manger	62.5	73.0	22.6	7.1	12.5	1.6	34.3	24.0	12.7	14.1	15.3

EARS OF CORN STOVER.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen—Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	ots h.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Upper Layer.											
As harvested	1021	614.4	406.6	6.1	46.3	26.5	310.2	17.5	7.4	1.6	2.9
Meal as fed	434	34.7	399.3	7.4	45.2	30.3	301.7	14.7	7.2	2.3	2.3
Losses, field to manger	587	579.7	7.3	+1.3	1.1	+3.8	8.5	2.8	0.2	+0.7	0.6
Percent of losses, field to manger	57.5	94.4	1.8	+	2.4	+	2.7	16.0	3.0	+	21.0
Middle Layer.											
As harvested	921	571.1	349.9	7 7	31.5	35.3	261.8	13.6	5.0	1.5	2.6
Meal as fed	334	27.5	306.5	6.7	35.0	25.7	227.2	11.9	5 6	1.8	1.6
Losses, field to manger	587	543.6	43.4	1.0	+3.5	9.6	34.6	1.7	+0.6	+0.3	1.0
Percent losses, field to manger	63.7	95.2	12.4	13.0	+	27.2	13.2	12.5	+	+	38.0
Lower Layer.											
As harvested	1044	645.	399.	8.5	40.8	33.3	298.6	17.8	6.5	2.1	3.2
Meal as fed	383	30.5	352.5	11.2	36.5	36.0	254.0	14.8	5.8	2.2	2.6
Losses, field to manger	661	614.5	46.5	+2.7	4.3	+2.7	44.6	3.0	0.7	+0.1	0.6
Percent losses, field to manger	63.3	95 3	11.6	+	10.5	+	14.9	17.0	10.7	+	18.7
Total.											
As harvested	2986	1830	1156	22	119	95	871	49	18.9	5.2	8.7
Meal as fed	1151	93	1058	25	117	92	783	41	18.6	6.3	6.5
Losses, field to manger	1835	1737	98	+ 3	2	3	88	8	0.3	+1.1	2.2
Percent losses, field to manger	61.4	95.0	8.5	+	1.7	3.2	10.1	16.3	1.6	+	25.3

RECORDS OF THE COWS INDIVIDUALLY AND BY GROUPS DURING THE EXPERIMENT.

COW AND GROUP.	Number of Period.	Experimental Fodder.	Preliminary Period. Dry Matter Eaten.*	Preliminary Period. Milk Given.	Experimental Period. Dry Matter Eaten.*	Experimental Period. Milk Given.	Experimental Period. Total Solids.	Experimental Period. Fat.	Experimental Period. Total Solids.	Experimental Period. Fat.	To 100 lbs. of Dry Matter in Experimental Fodders, these were given. Milk.	To 100 lbs. … Total Solids.	To 100 lbs. … Fat.
			lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.
Nancy B	I.	S. E.	90.2	261.4	159.9	474.0	12.52	3.70	59.35	17.59	296.4	37.12	11.00
	II.	W. E.	69.6	270.9	116.6	492.4	12.74	3.72	62.76	18.33	422.3	53.82	15.72
	III.	S. E.	81.2	259.4	120.0	466.8	12 93	3.92	60.35	18.30	308.9	50.30	15.25
	IV.	W. E.	51.7	229.4	109.8	431.8	12.91	3.91	55.77	16.92	393.2	50.79	15.41
	V.	S. E.	64.4	238.8	126.8	401.1	12.76	3.83	51.18	15.34	316.3	40.36	12.09
Dandelion	I.	S. E.	53.1	177.2	92.7	321.9	14.91	5.55	47.65	17.87	347.2	51.40	19.28
	II.	W. E.	32.8	186.6	63.2	310.4	15.14	5.74	47.00	17.83	491.1	74.37	28.21
	III.	S. E.	54.7	161.7	68 4	284.5	15.39	5.87	43 80	16.71	415.9	64.04	24.43
	IV.	W. E.	34.1	146.3	63.7	286.9	15.30	5.89	43.90	16.89	450.4	68.91	26.51
	V.	S. E.	53.1	155.2	111.3	275.3	14.99	5.74	41.27	15.79	247.3	37.08	11.18
Maizie	I.	S. E.	85.6	216.6	152.2	403.8	13.86	4.70	55.99	18.98	265.3	36.79	12.47
	II.	W. E.	66.3	239.7	117.1	401.8	13.74	4.48	55.21	18.01	343.1	47.[illegible]8	15.38
	IIr.	S. E.	93.1	220.7	134.1	380.1	13.90	4.59	52.84	17.46	283.4	39.40	13.03
	IV.	W. E.	61.2	189.1	110.5	377.7	13.94	4.72	52.66	17.74	341.8	47.66	16.05
	V.	S. E.	75.1	200.6	130.4	314.6	14.32	4.93	45.05	15.52	241.3	34.55	11.90
Atalanta	I.	W. E.	66.7	253.0	109.1	434.2	12.35	3.78	53.63	16.31	397.7	49.16	14.95
	II.	S. E.	63.2	252.6	105.7	434 9	12.27	3.65	53.36	15.89	411.4	50.48	15.03
	III.	W. E.	61.0	225.5	104.7	412.9	12.29	3.56	50.75	14.69	394.3	48.47	14.04
	IV.	S. E.	63.9	212.9	114 3	406.6	12.40	3.61	50.42	14.68	382.0	44.11	12.84
	V.	W. E.	44.2	217.9	102 0	374.3	12.27	3.68	45.92	13.76	366.9	45.02	13.49
Golden Rod	I.	W. E.	75.4	188.7	130.4	329.1	15.90	6.00	52.22	19.67	252.4	40.06	15.09
	II.	S. E.	82.8	195.8	164.9	316.2	16.60	6.29	51.55	19.88	191.7	31.26	12.06
	III.	W. E.	75.7	163.5	136.1	291.5	16.84	6.81	49.09	19.86	214.2	36.07	14.69
	IV.	S. E.	89.8	148.0	154.2	294.3	17.14	6.98	50.45	20.53	190.8	32.72	13.31
	V.	W. E.	74.0	158.6	136.4	273.5	17.02	6.97	46.55	19.06	200.5	34.13	13.98
Red Top	I.	W. E.	82.7	181.1	130.2	348.2	14.06	4.90	48.96	17.07	267.4	37.60	13.11
	II.	S. E.	87.1	206.5	139.7	340.6	14.15	4.88	48.21	16.64	243.9	34.51	11.91
	III.	W. E.	75.5	170.8	133.7	327.4	14.17	4.96	46.39	16.24	244.8	34.69	12.14
	IV.	S. E.	85.4	177.3	143.5	325.3	14.05	4.96	45.69	16.13	226.7	31.84	11.24
	V.	W. E.	69.5	172.7	127.9	311.2	13.96	4.78	43.33	14.87	243.3	33.89	11.67

GROUP 1.—NANCY B., DANDELION, MAIZIE.

I.	S. E.	228.9	655.2	404 8	1199.7	13.59	4.54	162.99	54.44	296.3	40.2	13.4
II.	W. E.	168.7	697.2	296.9	1204.6	13.69	4.49	164.97	54.17	405.7	55.5	18.2
III.	S. E.	229.0	641.8	322.5	1131.4	13.87	4.63	156.99	52.47	350.8	48.6	16.2
IV.	W. E.	147.0	564.8	284.0	1096.4	13.89	4.70	152.33	51.55	386.0	53.6	18.2
V.	S. E.	192.6	594.6	368.5	991.0	13 86	4.71	137.50	46.65	268.9	37.3	12.4

GROUP II.—ATLANTA, GOLDEN ROD, RED TOP.

I.	W. E.	224.8	622.8	369.7	1111.5	13.93	4.77	154.81	53.05	300.6	41.6	14.3
II.	S. E.	233.1	654.9	410.3	1091.7	14.03	4.80	153.12	52.41	266.1	37.3	12.7
III.	W. E.	212.2	559.8	374.5	1031.8	14.17	4.92	146.23	50.79	275.5	39.0	13.5
IM.	S. E.	239.1	538.2	412.0	1026.2	14.28	5.00	146.56	51.34	249.1	35.6	12.5
V,	W. E.	187.7	549.2	366.3	959.0	14.16	4.97	135.80	47.69	261.8	37.1	13.0

TOTAL OF ALL PERIODS FOR EACH GROUP.

Group 1	966	3154	1677	5623	13.78	4.61	774.8	259.3	335.3	46.2	15.5
Group 2	1097	2925	1933	5220	14.11	4.89	736.5	255.3	270.0	38.1	13.2

* In experimental ensilage.

INDEX.